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NUCLEAR SCIENCE ABSTRACTS

Volume I Number 9

Contents for November 15, 1948

Subject Category	Page
Absorption and Scattering of Radiation	403
Astrophysics	403
Atomic Power	403
Biological Effects of Radiation	404
Biology, General	405
Botany, General	406
Chemistry, Analytical	406
Chemistry, General	407
Control of Atomic Energy	408
Cosmic Radiation	408
Crystallography	410
Electronics	410
Fluorocarbons	411
Geophysics	411
Health Protection	411
Instruments	412
Laboratories	413
Mass Spectra	413
Mesons (Mesotrons)	413
Metallurgy	414
Mineral Resources	415
Mineralogy	415
Neutrons	415
Nuclear Physics	417
Nuclear Physics - Methods of Measuring	417
Nuclear Properties	418
Particle Accelerators	419
Physics, General	419
Quantum Mechanics	422
Radiation Sickness	425
Radioactivity	426
Radiochemistry	430
Radiography	430
Radiotherapy	431
Rare Earths	432
Scientific Research	433
Spectroscopy	433
Tracer Applications - Radioactive	435
Transuranic Elements	437
Uranium	437
X-Rays	437

Indices follow page 437

Location List of Declassified Documents

Document	Abstract	Page
AECD-2333	1515	437
AECD-2334	1420	413
AECD-2335	1378	403
AECD-2336	1431	415
AECD-2337	1406	411
AECD-2338	1395	407
AECD-2339	1407	411
NRC-1586	1432	415
NRC-1587	1433	416
NRC-1622	1379	404
NRC-1685	1380	404
NRC-1714	1418	413

ABSORPTION AND SCATTERING OF RADIATION

1374 **The Absorption of Incident Quanta by Atoms as Defined by the Mass Photoelectric Absorption Coefficient and the Mass Scattering Coefficient, by John A. Victoreen, Journal of Applied Physics 19, p. 855-860, September 1948.**

Previous empirical and theoretical expressions for the mass absorption coefficient are discussed. An empirical expression previously developed by the author (Journal of Applied Physics 14, p. 95, 1943) for the photoelectric absorption coefficient of an element, $T_a = C/f^3 - D/f^4$, is used to derive an expression for the mass photoelectric absorption coefficient. The constants C and D are obtained from the accepted spectral emission formula with the Sommerfeld relativity correction. Using the Klein-Nishina formula for the mass scattering coefficient σ/ρ, the following expression for the mass photoelectric coefficient is obtained:

$$\frac{T}{\rho} = \left\{\left(\frac{f_1 f_2}{f^3} - \frac{f_1 f_2 f_3}{f^4}\right)\omega\right\} 3/4\, \sigma \frac{N_0}{A}$$

in which σ is the classical scattering per electron, ω has the dimensions of a limiting angular velocity and f_1 and f_2 and f_3 critical frequencies obtained from the spectral emission formula. An empirically corrected expression for the total mass scattering coefficient is also given. Tabulated values of the calculated mass absorption coefficient μ/ρ are given for wavelengths from 0.01 to 40 angstroms for hydrogen and carbon and from 0.01 to λ_K and from λ_K to λ_L for aluminum, copper, tin, and lead. Graphs are given for these elements comparing calculated and observed values of the mass absorption coefficients.

1375 **On the Angular Distribution in Nuclear Reactions and Coincidence Measurements, by C. N. Yang. Physical Review 74, p. 768-772, October 1, 1948.**

Theorems concerning the general form of the angular distribution of products of nuclear reactions and disintegrations are derived on the basis of the invariant properties of the physical process, under space rotation and under inversion. The following examples are studied in detail: (a) angular correlation between the electron and the neutrino in beta decay; (b) angular correlation between a beta ray and a gamma ray emitted in succession by a nucleus; and (c) angular correlation between two gamma rays emitted in succession by a nucleus.

ASTROPHYSICS

1376 **Nuclear Physics and Cosmology, by A. Unsöld. Zeitschrift für Astrophysik 24, Nos. 3-4, p. 278-305, 1948. (In German)**

A discussion of the various estimates of the age of the universe is made. Assuming energy generation by conversion of H to He, the maximum ages for main sequence stars are calculated. The frequency of supernovae outburst is found to be consistent with the hypothesis that such outbursts are a stage in the evolution of short-lived bright stars. The origin and relative abundances of the elements is also discussed.

ATOMIC POWER

1377 **Atomic Energy in Peace and War, by J. M. Esparteiro. South African Journal of Science 44, p. 93-94, March 1948.**

The author summarizes the various effects atomic power and atomic weapons might have on the construction of warships and other naval craft, and on naval warfare.

1378 **Electrical Engineering for Atomic Energy, by D. W. Cardwell. AECD-2335, September 10, 1948, decl. October 7, 1948. 20 p. Document for sale by AEC.**

This paper surveys special problems in the field of electrical engineering which were presented by the atomic energy industry. The following topics are discussed: the electromagnetic process and

ATOMIC POWER (continued)

gaseous diffusion processes for isotopes separation, nuclear reactors or piles, radiation detection instruments, high energy particle accelerators and applications of atomic energy (military weapons, isotopes, atomic power). 20 references.

1379 The Fundamentals of Nuclear Energy, by G. Volkoff. NRC-1622, National Research Council of Canada, Atomic Energy Research Division Report. 7 p. (See also Journal of Chemical Education 24, p. 538-544, November 1947)

This discussion of the fundamentals of nuclear energy emphasizes the similarity between ordinary chemical and nuclear reactions. The following subjects are explained briefly: the nuclear model of the atom, the proton-neutron structure of the nucleus, analogy between molecular and nuclear reactions, heats of reaction of molecular and nuclear processes, relation between heats of formation of molecules and binding energies of nuclei, binding energy and mass-energy equivalence, beta and gamma activity, stable isotopes and deviations from stability, dependence of binding energy on number of nucleons, possibilities for energy release by regrouping the nucleons in a nucleus, requirements for a chain reaction, and the possibility of energy release by the complete annihilation of matter.

1380 Low-Energy Pile at Chalk River, by B. W. Sargent. NRC-1685, National Research Council of Canada, Atomic Energy Research Division Report, 1946. 10 p.

The first chain-reacting pile unit in operation outside the U. S. (September 5, 1945) was the uranium-heavy water nuclear reactor at Chalk River. The pile may be operated continuously at 3.5 watts and may be flashed to 30 watts. Ten tons of heavy water is the maximum used. Control rods and plates are of cadmium-plated steel. To reduce the critical size a graphite reflector is used. Some details of the construction of the pile and the auxiliary equipment are given. Fifteen photographs are included. Representative experiments in progress with the pile are discussed.

1381 Atomic Energy: Being the Norman Wait Harris Lectures Delivered at Northwestern University, by Karl K. Darrow. New York, John Wiley, 1948. 80 p.

This book is prepared for laymen because, as the author says, "Ignorance is not safe when the unknown may not be friendly; and since we discovered that matter is not invariably stable, the known has become so awesome as to suggest that the unknown can be unfriendly."

1382 Nuclear Reactions and Nuclear Energy, by S. N. Van Voorhis. Proceedings of the Institute of Radio Engineers 36, p. 1277-1282, October 1948.

An elementary discussion is given of nuclear reactions in general and the mass-energy interchanges characteristic of such reactions.

1383 Power Production from Nuclear Reactors, by E. J. Wiggins. Engineering Journal of Montreal 30, p. 268-275, June 1947.

The production of power from primary as well as from secondary piles is discussed. Schematic arrangements of several types of hypothetical nuclear power plants are outlined. The most promising immediate applications of nuclear energy and of radiation are considered and the effects of radiation on structural materials and on personnel are enumerated.

BIOLOGICAL EFFECTS OF RADIATION

1384 Effects of Radiation of Germ Plasm, by Ira I. Kaplan. Urologic and Cutaneous Review 52, p. 608, October 1948.

Recovery of germ plasm from the destructive effects of irradiation and restoration to normal physiologic functioning has not been held possible in the past. However, the author reports two cases

BIOLOGICAL EFFECTS OF RADIATION (continued)

in which sperm forming function was restored, and uses the statistics of 402 cases of married women treated by irradiation to bear out his contention that irradiation, when properly given, is not harmful to the mother or to the offspring and is a valuable therapeutic treatment for amenorrhea and the relief of sterility.

1385 Response of Kalanchoe Tubiflora to X-Radiation, by Edna L. Johnson. Plant Physiology 23, p. 544-556, October 1948.

The tiny plantlets bearing two pairs of leaves which drop from the leaves of Kalanchoe tubiflora, a Madagascar succulent of the Crassulaceae, were irradiated with 2500 r units of x-rays. Records kept of the vegetative and reproductive development of 216 plants for a period of three and one-half years showed growth stimulation during the first 17 months and branching in 20% of the irradiated plants, while none occurred in the controls. This branching delayed the time of blooming in the irradiated group as a whole. The treated group matured earlier but the average height was not as great as in the control group. Groups of plants averaging 8, 15, and 30 leaves each were irradiated with 2500 r units in order to determine the response to irradiation of plants older than those in the tiny plantlet stage. Vegetative growth and reproduction, as well as induction of branching, were increased only when very young plants and those up to and including the 8-leaved stage were irradiated.

BIOLOGY, GENERAL

1386 The Deposition of Uranium in Bone. Part I. Animal Studies, by W. F. Neuman, M. W. Neuman, and B. J. Mulryan. Journal of Biological Chemistry 175, p. 705-709, September 1948. (See also AECD-1915)

The study made of the distribution of uranium in animal tissues indicated that a large portion of the injected substance is accumulated in the bone. It was found that a direct relationship existed between growth activity and deposition of uranium in bone of the rat and that the amount of uranium in bone was greater in the young rat (male and female) than in older animals. In the case of rabbits, the concentration of uranium deposited in the bone was lower than that of rats of a corresponding age.

1387 The Deposition of Uranium in Bone. Part II. Radioautographic Studies, by M. W. Neuman and W. F. Neuman. Journal of Biological Chemistry 175, p. 711-714, September 1948. (See also AECD-1916)

In the rat radioautographs of bone containing U^{233} showed this element to be deposited only in the mineral portions and to be particularly concentrated on surfaces adjacent to the circulation and in areas of calcification. Once fixed, little redistribution of uranium occurred. As the normal growth and calcification processes continued, new bone accumulated over the lines of deposition and the resorption of bone to some extent was inhibited, probably because of the insolubility of uranium-impregnated bone salt. 2 plates (radioautographs).

1388 The Deposition of Uranium in Bone. Part III. The Effect of Diet, by W. F. Neuman, M. W. Neuman, Edna R. Main, and B. J. Mulryan. Journal of Biological Chemistry 175, p. 715-719, September 1948. (See also AECD-1917)

A study was made on the influence of several experimental diets upon the removal of uranium from the bone of rats. Neither the alkaline diet, consisting of fox chow supplemented with 0.5% sodium bicarbonate, nor the acidic diet, fox chow supplemented with 0.32% ammonium chloride, seemed to have any effect upon the rate of mobilization, while the rachitogenic diet, a modified Steenbock diet, Diet 2, increased the removal of uranium from the bone. It was observed that the half-life of skeletal uranium in the rat was in the order of 50 to 60 days.

BIOLOGY, GENERAL (continued)

1389 The Metabolism of Americium in the Rat, by Kenneth G. Scott, D. Harold Copp, Dorothy J. Axelrod, and Joseph G. Hamilton. Journal of Biological Chemistry 175, p. 691-703, September 1948. (See also AECD-1785)

An investigation of the metabolism of americium in the rat has been conducted, following its administration by intramuscular injection and by stomach tube. No appreciable absorption took place from the digestive tract. Within 24 hours after parenteral administration, 55% of the total amount of americium absorbed from the site of injection was deposited in the liver and 20% accumulated by the skeleton. Excretion occurred primarily by way of the digestive tract and most of the americium eliminated appeared to come from the liver. There was no significant change in the content of americium in the skeleton throughout the interval of the experiment. The distribution of americium in bone was studied by the radioautographic technique with thin, undecalcified sections of the femur. Americium was heavily deposited in the region of trabecular bone below the epiphysis, at the endosteal and periosteal surfaces of the shaft, and throughout the cortical bone in the region of small blood vessels. 2 tables, 3 graphs, and 2 plates (radioautographs). 7 references.

1390 The Toxicity of Dimethyl-, Diethyl-, and Diisopropyl Fluorophosphate Vapors, by S. D. Silver. Journal of Industrial Hygiene and Toxicology 30, p. 307-311, September 1948.

Information is presented on the vapor hazards in handling these compounds in the laboratory and in manufacturing. The determinations of median lethal concentrations for mice, eye effects of vapors on rabbits and humans, and median detectable concentrations by odor are reported on. The median lethal concentrations (LC50) for mice exposed for 10 minutes and observed for 10 days were 0.29 mg /liter for dimethyl-, 0.50 mg /liter for diethyl-, and 0.60 mg /liter for diisopropyl fluorophosphate. Miosis was caused in rabbits and human subjects by the vapors of all three compounds. The most severe and lasting effects were caused by the diisopropyl ester. The median detectable concentrations by odor were found to be 0.18 mg /liter for the dimethyl compound, 0.15 mg /liter for the diethyl compound, and 0.36 mg /liter for the diisopropyl compound. 4 references and 2 tables.

BOTANY, GENERAL

1391 A Technique for Introducing Radioactive Phosphorus into the Grain of Growing Corn, by H. G. M. Jacobson. Plant Physiology 23, p. 636-637, October 1948.

Corn grain of high quality and yield and containing a relatively high concentration of radioactive phosphorus needed for a poultry feeding investigation was produced by a gravel nutriculture procedure. Radioactive phosphorus in the form of KH_2PO_4 was added to the nutrient solution when the corn was in the early milk stage of kernel production. One hundred mg of the ground corn averaged 2800 counts per minute, and isolated calcium phylate averaged 47,040 counts per minute for a 100 mg sample to indicate an excellent concentration of radioactivity in the phytin phosphorus fraction.

CHEMISTRY, ANALYTICAL

1392 Method of Semi-Electrometric Titration of Titanium in Ferrotitanium, by Robert Lannet. Revue de Metallurgie 44, p. 286-291, September-October 1947. (In French)

This article describes a modification of the potentiometric determination method of Klinger, Stengel, and Koch, which is said to be more useful for industrial work and to require simpler apparatus.

CHEMISTRY, ANALYTICAL (continued)

1393 Quantitative Evaluation of Oxygen in Zirconium, by W. C. Lilliendahl, D. M. Wroughton, and E. D. Gregory. Journal of Electrochemical Society 93, p. 235-247, 1948.

Two methods of oxygen determination are reviewed and applied to the analysis of Zr. The first method involves the combustion of the metal and the calculation of the oxygen content by difference. This method is useful only for control purposes or where relatively large amounts of oxygen are present. Corrections must be made for hafnium and other oxygen-absorbing, inert, or volatile contaminants. The second method is a direct determination of ZrO_2 content by vaporization of the metal in Cl_2. The residue must be corrected for side reactions with C.

The precision is approximate 0.02% with 2.0-g samples; probably the results are a little low. Analysis of available Zr shows the following approximate oxygen values: Foot Mineral (wire), 0.04%; Bureau of Mines (Melted), 0.08%; and Westinghouse (powder), 0.13%. The microstructures of heat-treated Zr wires with and without added oxygen are shown. They show why, in some cases hardness increased with heating alone. A correlation between oxygen content and hardness was shown by microhardness measurements on a series of oxygen doped wires.

1394 A Rapid, Potentiometric Method of Simultaneous Determination of Chromium, Vanadium, and Manganese (Un Metodo Rapido per la Determinazione Contemporanea del Cromo, Vanadio e Manganese per via Potenziometrica), by Maria Teresa Gottardi. Annali di Chimica Applicata 38, p. 364-367, June-July 1948. (In Italian)

A rapid method is described which permits a quantitative determination of chromium, vanadium, and manganese in the same solution without the necessity of using separation procedures. The method is based on oxidation-reduction reactions, making use of the fact that the reaction potentials of the three elements lie sufficiently distant from each other. For the titration of manganese a solution of sodium arsenite is used, while the chromium and vanadium are determined together by titration with a ferrous sulfate solution. Then a solution of potassium permanganate is added and, after exactly one minute, an oxalic acid solution. The vanadium is then titrated with ferrous sulfate. The chromium content is then obtained by difference. A table is given, showing the results of the potentiometric titrations of chromium, vanadium, and manganese in various types of steel, as compared with the results obtained by volumetric methods. The figures are in excellent agreement for chromium and vanadium; in the case of manganese best results were obtained by titration with sodium arsenite as compared with those using mercurous nitrate and oxalic acid, respectively. The method described is of special importance in the analysis of steel, since the three elements may be determined by one single weighing procedure and in a single analysis.

CHEMISTRY, GENERAL

1395 Microsynthesis with Tracer Elements. Part I. The Synthesis of Urea Labelled With C^{14}; a New Synthesis of Cyanamide, by Arthur Murray and Anthony R. Ronzio. AECD-2338 (LADC-560), n.d., decl. October 8, 1948. 6 p. For publication in Journal of the American Chemical Society.

A method of synthesizing urea using barium carbonate containing C^{14} has been developed. The barium carbonate is converted to cyanamide with liquid ammonia and the cyanamide is in turn hydrolyzed to urea with concentrated sulfuric acid. A typical synthesis by this method gave a yield of 95.2% of product which melted at 125-130° and contained 1.977 millicuries of radioactivity per millimole.

1396 The Radiocarbon Story, by W. F. Libby. Bulletin of the Atomic Scientists 4, p. 263-266, September 1948.

A review is made of some of the principles of radiocarbon application, such as synthesis of organic compounds with C^{14} in a definite place in the molecule, and biosynthesis.

CHEMISTRY, GENERAL (continued)

1397 Synthesis of Carboxyl-Labeled Tryptophane from Hydantoin Containing Isotopic Carbon, by Howard W. Bond. Journal of Biological Chemistry 175, p. 531-534, September 1948.

The preparation of hydantoin labeled with isotopic carbon in position 4 from isotopic potassium cyanide proceeded in four steps according to the scheme, potassium cyanide→glycine→glycine ethyl ester hydrochloride→hydantoil ethyl ester→hydantoin. The labeled hydantoin was obtained in 57% yield. By using the labeled hydantoin for the synthesis, the corresponding carboxyl-labeled aminoacid, DL-tryptophane, was prepared in 59% yield.

CONTROL OF ATOMIC ENERGY

1398 "Middle-Run" Planning: Atomic Energy and International Relations, by William T. R. Fox. Bulletin of the Atomic Scientists 4, p. 227-232, August 1948.

The need for planned and rapid adaptation of world political organization is apparent. The Soviet-American will to collaborate must be developed in both countries. The first step toward international control is a rascal-proof inspection plan. The internationalization of enforcement action must follow at a later date. The first step would not banish war, but might conclude it before atomic destruction had been wrought on all the great cities of all the participants.

COSMIC RADIATION

1399 Cosmic Radiation, ed. by Dr. Heisenberg. New York, Dover Publications, 1948. 192 p.

This book consists of 15 separate articles by acknowledged experts in the field of cosmic radiation research, and taken together they cover a very extensive field of recent work. The editor gives an introductory survey of the present state of our knowledge of cosmic radiation, and also contributes a second article on the theory of cascades. The mesons in their various aspects are covered in eight chapters. Nuclear particles in cosmic radiation and geomagnetic effects are also discussed.

1400 Directional Intensity of Cosmic Rays at High Altitudes, by J. R. Winckler, W. G. Stroud, and J. Schenck. Physical Review 74, p. 837-838, October 1, 1948. (Letter to the editor)

Geiger counter telescopes, with and without lead filters, have been used to determine the directional intensity of cosmic rays at altitudes of 90,000 to 100,000 feet. The equipment consisted of five three-fold coincidence telescopes with counting axes pointed to zenith angles of 0°, $22\frac{1}{2}$°, 45°, $67\frac{1}{2}$°, and 90°, photocells being used to register azimuth. The counting rate as a function of height is shown for zenith angles of 0° (vertical) and $67\frac{1}{2}$° for lead thicknesses of 0, 1.9, 7.6, and 16.7 cm. used in the different flights. The same intensity is reached for the larger zenith angle as for 0°, but the curves of the former are displaced towards lower pressures. Taking into account the extra air path involved eliminates this displacement for the most part. Apart from small differences, the observed rays, including the soft secondary rays responsible for the maximum in the intensity height curves, preserve for the most part the direction of the rays producing them. Tabulated data for the soft and hard components absorbed by the lead at various altitudes are given. The data suggest that most of the radiation at 1 cm pressure is either extremely penetrating or else reacts in the lead to produce one or more penetrating secondaries which continue through the counter telescope. No asymmetry of the azimuthal effect was observed greater than the experimental error of 5%. These experiments are preliminary to an investigation of the directional distribution of the cosmic-ray intensity at high altitudes as function of latitude, which will be published in greater detail.

COSMIC RADIATION (continued)

1401 Nuclear Evaporations Produced by Cosmic Rays, by G. Bernardini, G. Cortini, and A. Manfredini. Physical Review 74, p. 845-846, October 1, 1948. (Letter to the editor)

"Stars" produced by cosmic radiation have been investigated using a photographic emulsion technique (Powell, Occhialini, and Lattes, Nature 159, p. 186, 1947; 159, p. 694, 1947; 160, p. 453, 1947; 160, p. 486, 1947) in a series of experiments performed both at the L. T. G. (Laboratorio della Testa Grigia), which is 3500 meters above sea level, and in balloon flights at altitudes of 18 kilometers and 22 kilometers. Tabulated data of the number of stars/cc/day as a function of the interposed lead plate thickness are given for 0 to 13 cm of lead. Only stars having at least three observable prongs were counted. From these data the absorption coefficient of lead for the radiation producing these stars was estimated roughly as $1/300\ g^{-1}cm^2$. The transition effect was neglected in arriving at this value. To account for the finite size of the lead blocks, a 20% enlargement of the absorption coefficient was necessary. Comparing the balloon flight data with those obtained at L. T. G., the absorption coefficient for air with respect to the star-producing radiation was found to be $1/(141 \pm 12)\ g^{-1}cm^2$, which is in good agreement with that of Perkins from single proton tracks (Nature 160, p. 707, 1947). Data are shown graphically of the distribution as to number of prongs. The shape or the distribution curve varies little for the different cases represented by the histograms (Communication by Professor L. W. Alvarez at the Zurich Congress, July 1948), which supports the assumption that the processes by which the stars arise are roughly independent of the energy of the radiation which produces them. The close correlation between these data and the burst experiments (Bridge and Rossi, Physical Review 71, p. 379, 1947; Bridge, Rossi, and Williams, Physical Review 72, p. 257, 1947; Tatel and Van Allen, Physical Review 73, p. 87, 1948) is noted. The low absorption coefficient obtained for lead indicates that no appreciable fraction of the stars is due to the electron-photon component. Since the ratio between the number of stars registered at 3500 meters and at sea level is 15/1, while the corresponding meson intensity ratio is only 2/1, it is concluded that high energy nucleons and σ-mesons are primarily responsible for the stars. The total cross section of the latter component is deduced to be $3A^{2/3} \times 10^{-26}\ cm^2$ by comparing the measurements for air and lead.

1402 On the Lateral Extension of Auger Showers, by S. F. Singer. Physical Review 74, p. 844, October 1, 1948. (Letter to the editor)

Cocconi (Physical Review 72, p. 350, 1947) has advanced an explanation of discrepancies in the shower experiments of Skobeltzyn, Zatsepin, and Miller (Physical Review 71, p. 315, 1947). This explanation has been extended and given experimental confirmation by the author. In the earlier experiments a higher coincidence rate was found at large counter separations than was expected from the curve of coincidence rate as a function of counter separation which was calculated using a primary electron shower model. Cocconi eliminated this difficulty by taking into account the effect of showers incident at large zenith angles, which is more important at large counter separations. The author finds the net effect is an increase in counting rate smaller than that calculated by Cocconi. This was tested experimentally by taking data with counters in two different relative positions, in one of which the effect of this type would be much greater. At large separations the expected changes in counting rate were observed.

1403 On the Production of Showers of Penetrating Particles, by H. A. Meyer, G. Schwachheim, and Andrea Wataghin. Physical Review 74, p. 846-847, October 1, 1948. (Letter to the editor)

The cross section for the production of penetrating particles in various materials was studied using lead shielded telescopes, separated by 16 cm of lead, of the type previously used by Wataghin (Physical Review 71, p. 453, 1947). An equal number of nucleons (equal masses) of different materials were distributed in the same volume and the frequency of shower production in these materials was obtained as the difference between shower frequency measurements made with and without the materials. Tabulated frequency data obtained for H_2O and Fe (filings) are given. The registered cross

COSMIC RADIATION (continued)

section per nucleon is larger for the water, indicating that either the absorption coefficient of primaries or the constitution and multiplicity of the produced showers depends on the nuclear structure. With 57 g cm^{-2} of either material saturation was observed, the difference between the frequency of production of showers at saturation for the two materials suggesting that the constitution, multiplicity, or angular divergence of the produced showers is different for the two cases. The intensity of the shower-producing radiation is reduced by a factor slightly larger than 1/e in a thickness of 57 g cm^{-2} for both materials. It is concluded that the lower level of the cross sections of this radiation for both materials is of the order of the geometrical cross sections of the nuclei. A second series of experiments is being performed in which equal numbers of nuclei of two different elements are distributed in equal volumes, in which case the frequency of shower production in the two materials is proportional to the average cross sections of the respective nuclei.

CRYSTALLOGRAPHY

1404 Table of Interplanar Spacings in Terms of 2θ for Different Target Materials, by S. Beatty. Research Report from Westinghouse Research Laboratories, R-94602-10-A, October 29, 1947. 20 p.

This table has been computed to expedite the reduction of diffraction patterns obtained with a recording Geiger counter X-ray spectrometer where line intensities are given as a function of 2θ. The table gives d values in Angstrom units for Mo, Cu, Co, Fe, and Cr targets between the 2θ values 5 and 85 degrees inclusive. Every tenth of a degree is listed between 5 and 70 degrees, every two tenths between 70 and 80 degrees, and every five-tenths between 80 and 85 degrees. Since the argument is in angular units, no reductions are necessary to compensate for different counter-arm lengths, motor rates, etc. The values of the interplanar spacings d, are computed from the Bragg equation: $n\lambda = 2d \sin\theta$, where θ is the glancing angle, λ the wavelength of the diffracted target radiation, and n is taken as unity in this case. The table is computed for the K_{α_1} radiations as follows:

Mo	.7078	Co	1.7853	Cr	2.2850
Cu	1.5374	Fe	1.9321		

ELECTRONICS

1405 Energy Levels in Oxide Cathode Coatings, by D. A. Wright. Proceedings of the Physical Society 60, Part I, p. 22-27, January 1, 1948.

Previous theories of the mechanism of emission of electrons from a metallic cathode coated with the double oxide of barium and strontium are discussed. These theories all assume that excess barium is freed in the coating, thus raising its conductivity compared with that of the free oxide. This barium is freed by electrolysis or by chemical reaction with reducing agents in the core metal or coating. Energy level diagrams are shown for excess semi-conductors under various conditions. From various considerations it is concluded that the thermionic emission from BaO or Ba/SrO is emission from the conduction band of the semi-conductor, the bottom of which is situated not more than 0.6 ev and probably only 0.3 ev below the zero level. The process of activation consists of building up a sufficient concentration of free Ba in the oxide to lower the work function to 1.ev, and in providing a layer of adsorbed Ba at the coating-core interface. At the outer coating surface Ba is not appreciably involved, if at all, in lowering the work function to the observed value of 1 ev in the activated cathode. When electrons are raised into the conduction band of a semi-conductor, as under the influence of ultra-violet light or electron bombardment, the conductivity is increased. The increase in the number of electrons in the conduction band should also increase the thermionic emission and may possibly cause photochemical decomposition as well. Evidence for this is discussed.

FLUOROCARBONS

1406 Solubility of Water in Perfluorodimethylcyclohexanes as a Function of Temperature, by James L. Gabbard, E. S. Amis, and J. H. Jamieson. AECD-2337 (K-238), July 21, 1948, decl. October 13, 1948. 9 p. Informal disposition and for possible publication.

The solubility of water in perfluorodimethylcyclohexanes was determined at ten degree intervals from 15° to 85°C. A diagram of the absorption apparatus used is included. The solubility is adequately expressed by the empirical equation $X = 7.23 - 0.1131t + 0.01818\,t^2$ where X is solubility in ppm and t is temperature in degrees Centigrade.

1407 Special Chemicals for the Manhattan Project, by R. Rosen. AECD-2339, n.d., decl. October 5, 1948. 4 p. For inclusion in NNES.

This paper briefly discusses the preparation of some of the special chemicals (fluorine and certain fluorinated hydrocarbons, especially C_7F_{16} and C_8F_{16}) required by the Manhattan Project. The method of handling the research work and the subsequent larger scale work with these chemicals is outlined.

1408 Chlorobenzotrifluoride. Chemical Engineering 55, No. 9, p. 186, September 1948. (In New Products and Materials Section)

The product m-chlorobenzotrifluoride (m-chlorotrifluoromethylbenzene) is now available in pilot plant quantities from the Hooker Electrochemical Co., Niagara Falls, N.Y.

1409 The Di-fluorobibenzyls, by M. Szwarc and J. S. Roberts. Journal of the American Chemical Society 70, p. 2831, August 1948.

Investigations of the pyrolysis of the fluorotoluenes show that the fluorobenzyl radicals produced dimerized to the corresponding di-fluorobibenzyls. The melting points, boiling points, and the results of elementary analyses are given.

GEOPHYSICS

1410 Significance of the Radioactivity of Potassium in Geophysics. Part II, by T. Gráf. Physical Review 74, p. 831-832, October 1, 1948. (Letter to the editor)

The estimates of the radioactive heat production of potassium of Gleditsch and Gráf (Physical Review 72, p. 641, 1947) have been revised to agree with revised values for the half-life of potassium. Using the new data, i.e., $(13.7 \pm 1.5) \times 10^8$ years for the beta-decay period, 1.8 ± 0.5 for the branching ratio, and $(5 \pm 1.5) \times 10^8$ years for the total half-life of K^{40}, the radioactive heat production of K^{40} has been determined as $(22 \pm 3) \times 10^{-6}$ cal/year/gm of K. Assuming the average potassium content of acidic igneous rocks is 2.8%, the heat production as a result of potassium radioactivity is $(0.6 \pm 0.1) \times 10^{-6}$ cal/year/gm of rock, i.e., about 11% of the total radioactive heat. Recent cloud chamber experiments of Franchetti and Giovanozzi (Physical Review 74, p. 102, 1948) which might alter these values are discussed, along with Suess's conclusion that the branching ratio would equal the gamma:beta ratio if, as he assumes, all the capture processes in K^{40} lead to an excited argon atom (Physical Review 73, p. 1209, 1948. The new half-life determinations are used to explain the origin of atmospheric argon.

HEALTH PROTECTION

1411 Industrial Health and Hygiene -- Review 1947, by Harold H. Steinberg. Industrial Medicine 17, No. 4, p. 105-115, April 1948.

An index of 67 references is included and most of the references in the index are discussed. Much space is devoted to preventive medicine, occupational cancer, aviation medicine and atomic medicine. Skin diseases, dust exposures, metals and their compounds and industrial gases and solvents are also reviewed.

HEALTH PROTECTION (continued)

1412 Protection Against Radiation Hazards and Maximum Allowable Exposure Values, by Karl Z. Morgan. Journal of Industrial Hygiene and Toxicology 30, p. 286-293, September 1948. (See also MDDC-937)

The development of health physics is traced and radiation protection precautions taken on the Plutonium Projects are briefly summarized. A table showing daily tolerance values for gamma radiation, alpha particles, beta particles, fast neutrons, and thermal neutrons is given as is a table showing tolerance values for several radioisotopes. 17 references.

INSTRUMENTS

1413 Beryllium Films as Object Supports in the Electron Microscopy of Biological Specimens, by V. E. Cosslett. Biochimica et Biophysica Acta 2, p. 239-245, August 1948.

In the electron microscopy of objects of the order of 100 Angstrom units in size, especially of a biological nature, the thickness of the supporting film has an important effect on the contrast and resolution in the image. Beryllium films are preferable to collodion in such circumstances, as they can be made thinner for the same limiting mechanical strength, and have approximately the same scattering power per unit thickness. A technique is described for forming beryllium films directly on the specimen. An alternative method is to pre-form a film and then deposit the specimen on it, but this gives less good contrast. Films as thin as 25 Angstrom units can be prepared and manipulated without undue difficulty. Examples are shown of the value of such supporting films in the investigation of plant and animal viruses, and in the examination of the fine structure of bacteria, such as flagella.

1414 Conference on Electronic Instrumentation in Nucleonics and Medicine. Science 108, p. 407, October 15, 1948.

This conference will be held in New York City November 29 through December 1. There will be a comprehensive display of radiation detection instruments essential to nuclear energy applications.

1415 High Temperature Thermodynamics of Inorganic Substances, by Herrick L. Johnston. Ohio State University Research Foundation Quarterly Progress Report No. 5, October 1, 1947. 8 p. (TIP U1383)

The high temperature drop calorimeter, which uses induction heating, is almost complete. A diagram of the inductively heated calorimeter furnace is enclosed. The construction of a high temperature x-ray diffraction camera with its high voltage source and furnace elements is described in detail. (TIP Abstract).

1416 An Interferometric Method for the Calibration of Electron Microscope Magnification, by J. L. Farrant and A. J. Hodge. Journal of Applied Physics 19, p. 840-844, September 1948.

Previously used methods of calibration of the electron microscope are discussed. The diameters of 5-micron uniform cylindrical silica and glass fibers can be measured interferometrically with less than 1% error. A measured fiber can then be mounted and used for permanent direct calibration. Typical fiber interference patterns and microphotometer traces of transmission plotted against distance are shown, and the method of using these to determine the interference band order at the fiber is described. Such fibers can be used to calibrate magnifications up to 10,000 diameters. Using a 0.5-micron diameter glass sphere which has been calibrated internally by comparison with the measured fiber, it is possible to determine higher magnification ranges up to the 20,000 diameters maximum value of commercial instruments. The sphere is also used to determine the necessary correction for radial distortion in the fiber diameter measurements, and a method for doing this is given. A table of magnification values for a single microscope setting obtained using six different fibers is given.

INSTRUMENTS (continued)

1417 Some New Aspects of High-Speed Oscillography, by D. M. Mackay. Proceedings of the Physical Society 61, p. 235-245, September 1, 1948.

From a consideration of the mechanism of the cathode-ray oscillograph at very high speeds it is shown that conventional deflection systems do not fully realize the possibilities of the cathode-ray tube. By a modification of the shape of the deflector-plates it is theoretically possible, under suitable conditions, to expand the time-scale obtainable with a given time-base generator up to infinity. This gain is obtained at the expense of definition, but brightness is not affected. Relativistic considerations are shown to be irrelevant. The geometry of the deflected electron beam is examined, and an expression derived relating the shape of the effective time-base voltage wave-form, the time-scale, and the shape of the Y-plates. Practical factors which cause various forms of trace distortion are discussed, i.e., (1) intermodulation effects, (2) mismatching distortion, (3) transit-time effects, and (4) defocusing and equivalent effects. Possible ways of overcoming some of these difficulties are described.

LABORATORIES

1418 Design, Auxiliary Equipment and Services For a Radiochemical Laboratory, by G. H. Guest, and L. G. Cook. NRC-1714 (CRHR-368), National Research Council of Canada, Atomic Energy Research Division Report, February 14, 1948. 12 p.

The following features are desirable in a radiochemical laboratory: Floor area should be at least 200 square feet. Provision should be made for performing all work with radioactive materials in fume hoods. All walls, floors, and furniture should be easily cleaned. Floors and benches should be strong enough to support lead brick shielding. Health instruments, film monitoring, special laboratory clothing, special cleaning services and facilities for disposal of radioactive film materials, should be provided.

MASS SPECTRA

1419 A Radio-Frequency Mass Spectrometer. National Bureau of Standards Technical News Bulletin 32, p. 105-108, September 1948.

A specially designed vacuum tube is incorporated in a greatly simplified and flexible radio-frequency mass spectrometer, which provides an extremely valuable method for detecting, separating, identifying, and measuring negative atomic ions of the heavier metallic elements. In a modified form, it may also be used for positive ions. Pictures are shown of the tube.

MESONS (MESOTRONS)

1420 Positive Mesons Produced by the 184-Inch Berkeley Cyclotron, by John Burfening, Eugene Gardner, and C. M. G. Lattes. AECD-2334 (UCRL-171), n.d., decl. October 6, 1948. 19 p. For publication in Physical Review.

An abstract of this document has been issued as AECD-1923 and listed in Abstracts of Declassified Documents.

1421 The Absorption of Charged Particles from the 2.2-μ sec Meson Decay, by E. P. Hincks and B. Pontecorvo. Physical Review 74, p. 697-698, September 15, 1948.

The authors attempt to obtain information about the energy of the charged particles (commonly assumed to be electrons) emitted in the 2.2-μ sec meson decay by measuring their penetration through a solid absorber. A section of the counter arrangement, together with a diagram showing the function of the electronic circuit, is shown and a table of results is given. It is concluded that (1) decay electrons having energies greater than 25 Mev are present, (2) the 2-particle decay process (charged meson $\longrightarrow$ electron + neutral meson) with a unique energy of about 25 Mev for the decay electron is incompatible with the results, and (3) a maximum energy of about 50 Mev for the decay electrons is consistent with the results.

MESONS (MESOTRONS)

1422 A Determination of the Ratio of the Masses of π- and μ-mesons by the Method of Grain-Counting, by C. M. G. Lattes, G. P. S. Occhialini, and C. F. Powell. Proceedings of the Physical Society 61, Part 2, p. 173-183, August 1, 1948.

More than thirty events in which secondary μ-mesons, produced by π-mesons, have been recorded, and the results are tabulated. Tables of the grain counts of μ-mesons as well as π-mesons are given, together with logarithmic plots of range versus grain count and examples of photomicrographs of the decay tracks. The principle behind the determination of the ratio is given, and the method described in detail. The mass ratio $m_\pi/m_\mu = 1.65 \pm 0.11$. It is assumed that the μ-mesons, identical with the ordinary cosmic ray mesons, result from the decay of the heavier π-mesons. From the results it is concluded that a neutral meson (rest mass = $115 \pm 30\ m_e$) provides the momentum balance. The following limits for the half-value periods have been determined: π-mesons, $>0.4 \times 10^{-10}$ sec , μ-mesons, $>2 \times 10^{-10}$ sec ; ν-mesons (assumed neutral meson), $>2.6 \times 10^{-21}$ secs.

1423 Elimination of Divergences in the Meson Theory. Part I, by Mario Schönberg. Physical Review 74, p. 748-760, October 1, 1948.

A previously introduced method (Physical Review 74, p. 738, 1948; Anais da Academia Brasileiria de Ciencias, in print) for eliminating the divergences in the meson theory is developed for the case of pseudoscalar charged mesons. The quasi-static forces between the nucleons are treated as relativistic "actions at a distance." Two independent complex pseudoscalars enter into the description of the meson field. As is shown, the "action at a distance" treatment enables the separate choice of the type of nuclear forces and the form of the interaction with the meson field. This convention, with its associated special rules of interpretation, leads to finite transition probabilities; it is also applicable to self-energy problems. In the latter case, the computation of the finite self-energies and magnetic moments which result involves two constants which may be chosen in such a way as to give different masses to the proton and neutron.

1424 On the β-Decay of Mesons, by J. J. Horowitz, O. Kofoed-Hansen, and J. Lindhard. Physical Review 74, p. 713-717, October 1, 1948.

Following a general discussion of theories of the beta decay of cosmic-ray mesons, the possibility of meson decay into an electron, neutrino, and a neutral particle is treated in detail. Tabulated values of f·t for the lightest elements are given, where "f" is the Fermi integral of the distribution in energy of the electron and the neutrino as estimated for a maximum energy of the electron of 2 x 25 Mev $\cong 100\ m_e$. These data serve as a basis of comparison, with reservations, with the beta decay of the meson. Taking the energy of the recoil particle into account, the Fermi integral is evaluated for the postulated beta-decay process and an expression for the electron energy spectrum is obtained. Values of M, m, E_{max}, m_π/M and f·t for the average energy values of 45, 50, and 55 m_e have been tabulated, where M is the mass of the meson decaying to give a neutral particle of mass m, and m_π is the mass of a pi-meson. These computed values are compared with related experimental data.

METALLURGY

1425 Elementary Physical Metallurgy, by Edward G. Mahin. New York, Chemical Publishing Co., 1948. 276 p.

Starting with the microscope and the preparation of metallographic specimens this book deals with fundamental properties of materials and their relationship to one another, methods of testing and interpretation of these results. Detailed treatments of hardness, thermal analysis, pyrometry and phase diagrams are featured.

METALLURGY (continued)

1426 Metallurgical Materials and Processes, by John Elberfeld. New York, Prentice-Hall, 1948. 188 p.

Such topics as grain structure, constitution diagrams, heat-treatment furnaces and their controls, forming of metals, welding metallurgy, powder metallurgy, and laboratory procedures are included.

1427 These New Metals Challenge Old Stand-bys. Modern Industry 15, p. 50-53, June 1948.

The advantages of using titanium, zirconium, and molybdenium as substitute metals for chromium, tungsten, and even aluminum and steel are given. Applications are illustrated and a pictorial comparison chart of the properties of the metals are included.

1428 Titanium and Zirconium -- New Metals in Australian Metallurgy, by H. W. Worner. Chemical Engineering and Mining Review 40, p. 254-262, 1948.

The properties and uses of titanium and zirconium are reviewed. The production of titanium from rutile and zirconium from zircon and refining of these metals are discussed. 39 references.

MINERAL RESOURCES

1429 Deposits of Titanium Ore in Canada. Chemical Engineering 55, No. 9, p. 71, September 1948. (In Chementator, Comments on the New of Chemical Engineering in Industry, Section)

Upwards of 125 million tons of high-grade titanium-bearing ilmenite ore have been located at Tio Lake in the Allard Lake region of Quebec. The ore averages 35% TiO_2 and 40% Fe. The smelter is being built at Sorel, Quebec, and will turn out annually about 250,000 long tons of titanium dioxide slag.

MINERALOGY

1430 Absorption Factor in Counting Alpha Rays from Thick Mineral Sources, by H. H. Nogami and P. M. Hurley. Transactions of the American Geophysical Union 29, p. 335-340, June 1948.

By counting the alpha emission from a thick layer of a powdered sample and applying the appropriate absorption factor, a measurement of the combined uranium and thorium content in most minerals and rocks can be made.

NEUTRONS

1431 Evidence for and Cross Section of 115 Day Selenium Seventy-Five, by H. N. Friedlander, L. Seren, and S. H. Turkel. AECD-2336, n.d., decl. February 25, 1947. 6 p. For publication in Physical Review.

Evidence has been given to show that the 115-day activity produced in selenium by thermal neutrons is due to Se^{75} which decays by K-electron capture to As^{75}, accompanied by an 0.4 Mev x-ray. A value of 22×10^{-24} cm^2/isotopic atom or 0.2×10^{-24} cm^2/natural atom for the cross section of Se^{74} for radiative capture of a thermal neutron has been given.

1432 The Development of a Source of Fast Neutrons of Variable Energy. Part I. High Intensity of Ion Sources, by W. E. Burcham. NRC-1586 (MP-176), National Research Council of Canada, Atomic Energy Research Division Report, September 13, 1945. 30 p.

Three main types of ion sources for use in the production of homogeneous neutrons from the reaction $C^{12}(d,n)N^{13}$ are low pressure discharge tubes, low voltage arcs and electron beam types.

NEUTRONS (continued)

The principle of operation and general characteristics of all three types are discussed. Experimental investigations of a low voltage arc and two electron beam sources (cold cathode reflection type and cyclotron type) have been carried out. The main disadvantage of the low voltage arc is the heavy duty cathode required, and the low and variable percentage of atomic ions. The cold cathode reflection source is subject to uncertainty of operation and the design is not yet final. At the present time the cyclotron type is considered the most suitable source for use in the production of C^{12} neutrons. Three diagrams of apparatus, two graphs indicating results and twelve references are included.

1433 Development of a Source of Fast Neutrons of Variable Energy. Part II. The Ottawa High Tension Set, by W. E. Burcham, E. B. Paul, and J. V. Jelley. NRC-1587 (MP-178), National Research Council of Canada, Atomic Energy Research Division Report, October 19, 1945. 22 p.

A 600 kv x-ray set has been modified for use in the development of a $C^{12}(d,n)N^{13}$ neutron source. A general description of the equipment is followed by a more detailed description of the following components: the accelerating tube, the pumping system, the ion source, the power column, and auxiliary equipment. General suggestions for operation and a discussion of present performance and work still required are included. Two diagrams and six photographs show various parts of the equipment.

1434 Elastic Scattering of High Energy Nucleons by Deuterons, by Geoffrey F. Chew. Physical Review 74, p. 809-816, October 1, 1948.

The elastic scattering cross section of deuterons for neutrons and protons of 90 and 350 Mev has been calculated, using the non-relativistic Born approximation. Two different approaches give roughly the same result: a total neutron-deuteron elastic cross section of about half the neutron-proton cross section at the same energy but sharply confined to small angles. The half-width at 90 Mev is about 15° in the laboratory system. The proton-deuteron elastic scattering is similar to the neutron-deuteron for large angular deflections, but at 90 Mev a difference due to the Coulomb repulsion should be noticeable within 10°. It is concluded that the assumption of a simple additivity of nucleon-nucleon cross sections for light elements is unjustified.

1435 Photodisintegration of Deuterium and Beryllium by Thorium C'' γ-Rays, by D. L. Allan and M. J. Poole. Nature 162, p. 373-374, September 4, 1948.

Two different methods were used to measure the ratio between the numbers of neutrons emitted from deuterium and beryllium sources made by placing 300 millicuries of radium-thorium in the center of spheres of heavy water and beryllium, respectively. The γ-rays from thorium C''(Tl^{208}) have an energy of 2.62 Mev. The first method used a large tank of water to slow down the neutrons. The slow neutron density set up in the tank was determined by using neutron-irradiated manganese foil detectors, the β activity of which was then measured using a Geiger Counter. From the ratio $N_{Be}/N_D = 1.26 \pm 0.03$ the correct ratio of the photo-disintegration cross sections becomes

$$\frac{\sigma(\gamma,n)Be}{\sigma(\gamma,n)D} = 0.35 \pm 0.01$$

which agrees well with the value of Russell, Sachs, Wattenberg, and Fields (Physical Review 73, p.6, 1948) who found values of 0.30 at 2.50 Mev γ energy and 0.43 at 2.76 Mev γ energy. The second method used the "long counter" (Hanson and McKibben, Physical Review 72, p. 8, 1947) and yielded a value of

$$\frac{\sigma(\gamma n)Be}{\sigma(\gamma n)D} = 0.36 \pm 0.03$$

which is in good agreement with the first method.

NUCLEAR PHYSICS

1436 Atomic Artillery (Artillerie Atomique) 2nd ed., by Maurice Elie Nahmias. Paris, Librairie Polytechnique C. Beranger, 1947. 201 p. (In French)

By the term atomic artillery is meant such projectiles as neutrinos, electrons, positrons, mesotrons, neutrons, protons, deuterons, and alpha rays. The second edition was prepared in 1946 and has a supplement on the experiences at Bikini. The book itself reviews the advances made in such fields as: modern techniques for acceleration of ionized particles; electronic projectiles and X-rays; the electron microscope; biological action of radiations; radioactivity in biology; nuclear chemistry, astrophysics, and cosmic rays; the atomic bomb and the industrial use of atomic energy.

1437 Conference at Oak Ridge. Journal of Applied Physics 19, p. 866, September 1948.

The Oak Ridge National Laboratory Conference on Low Temperatures and Nuclear Physics was held August 7 and 8. Speakers and their subjects were as follows: Alignment of Nuclear Spins, by M. E. Rose; Nuclear Relaxation Phenomena at Low Temperatures, by E. M. Purcell; Thermal Equilibrium at Low Temperatures, by H. B. G. Casimir; and The Superfluid State, by F. London.

1438 Nature and Cognition; the World in the Development of Today's Physicists (Natur und Erkenntnis; die Welt in der Konstruktion des Heutigen Physikers), by Arthur March. Vienna, Springer-Verlag, 1948. 239 p. (In German)

The fundamental ideas of modern physics are presented for the layman in non-mathematical form. The nature of particles and of waves is described and an attempt is made to discuss the concepts of quantum mechanics on this level. A major part of the book is devoted to a discussion of the idea of a fundamental smallest length and the limitations of the analysis of space and time relations. Some philosophical implications of the quantum theory are discussed.

1439 Nuclear Radiation Physics, by H. E. Lapp and H. L. Andrews. New York, Prentice-Hall, 1948. 483 p.

Since the publication of the Smyth Report there has been no comprehensive and up-to-date textbook on atomic energy. This book is a complete textbook on nuclear energy, ranging from a treatment of radioactivity through nuclear fission. It includes a separate chapter on tracers and one on the new field of health physics. The chapters on nuclear fission contain almost all the recently declassified data. Nuclear reactions produced by high energy particles are also discussed and the phenomenon on meson production is included. Throughout the text, the approach to even complex phenomena is direct and in most cases accomplished with minimum recourse to mathematics. To facilitate comprehension by the lay reader, the authors have included many illustrative examples. Included at the end of each chapter are problems for the student and a list of references for the advanced reader.

1440 Some Engineering Problems of Atomic-Energy Research, by O. C. Simpson. Mechanical Engineering 70, p. 729-732, September 1948.

The author describes in a general way the engineering problems connected with accelerators, nuclear reactors, isotope separators, remote control, and shielding and ventilating.

NUCLEAR PHYSICS - METHODS OF MEASURING

1441 Applications of the Obliteration of Latent Images to the Study of Nuclear Reactions (Application de l'Effacement des Images Latentes à l'Etude des Reactions Nucleaires), by Henriette Faraggi. Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences 227, p. 527-528, September 6, 1948. (In French)

A photographic emulsion method used to determine range-energy relations for particles emitted in a nuclear reaction in which the recoil energy of the nucleus is not negligible is described. In such cases data taken in a Wilson chamber are inadequate for determination of the range of the emitted

NUCLEAR PHYSICS - METHODS OF MEASURING (continued)

particle, since such a track is the resultant of the path of the emitted particle and that of the residual nucleus. When photographic emulsions are used, it is possible to observe the origin of the transmutation, i.e., two separate tracks may be measured, as the origin of the latent image of the track of the particle will disappear first. Curves of the number of traces as a function of trace-length are given for He^4 and H^3 formed in the neutron bombardment of Li^6; data for both total track length (as ordinarily observed) and individual track lengths for the two particles determined by the method described are shown. The relationship between range and the calculated energy released is shown in tabular form for the He^4, H^3, and H^1 particles. The range-energy relations obtained show agreement with previous determinations. This method should be of value in: 1) obtaining ranges of light particles and determining reaction energies with precision; 2) establishing precise range-energy determination for light particles with known energies of reaction; and 3) establishing more exact range-energy correlations for the recoiling residual nucleus.

1442 Scintillation Counters with Napthalene, by Martin Deutsch. Laboratory for Nuclear Science and Engineering, Massachusetts Institute of Technology Technical Report No. 3, 7 p. (TIP U1385)

H. Kallman has reported (Natur und Techniq, 1947) some investigations concerning scintillation counters, using naphthalene screens and photomultiplier detectors. The advantage of naphthalene over conventional phosphors is that it is very transparent to its own fluorescent radiation and permits detection of beta rays and gamma rays. Ordinary moth crystals and 931A photomultipliers have been used at MIT. Of a dozen war surplus 931A tubes tested, all counted gamma rays with reasonable efficiency at room temperature when the voltage per stage, gain, and discriminator bias were adjusted to admit background counts of a few hundred per minute. A graph is included which shows count versus bias curves for Co^{60} gamma rays and Cs^{134}. Bias curves for continuous beta ray spectra of different end point energies obtained at room temperature are given. (TIP Abstract).

1443 Selective Development of Fission Tracks in an Electron-sensitive Emulsion, by G. W. W. Stevens. Nature 162, p. 526-527, October 2, 1948.

The author describes how, by using controlled under-development, he was able to utilize an electron-sensitive emulsion for the selective recording of fission products. The developer used was special low-energy para-aminophenol. "Elon" (methyl p-aminophenol sulphate), glycin, and hydroquinone in adjusted solutions could also be used. Photomicrographs of fission tracks are given.

NUCLEAR PROPERTIES

1444 Nuclear Forces, by L. Rosenfeld. New York, Interscience Publishing Co., 1948. 181 p.

Part I, on the general features of nuclear forces, deals with properties of nuclear particles, nuclear radii and mass-defects, and charge dependence of nuclear forces. Part II, on two-nucleon systems, considers dynamical variables and fundamental equations, the stationary states and physical properties of the proton-neutron system, central interaction between protons, and the charge independence of nuclear interaction.

1445 On Models for Be^9, by Eugene Guth and Charles J. Mullin. Physical Review 74, p. 832-833, October 1, 1948. (Letter to the editor)

The predicted values for the ground state and the magnetic moment of Be^9 using three different nucleus models are compared with experimental evidence of a spin of 3/2 (Julian Schwinger, personal communication) and a magnetic moment of -1.18 nuclear magneton (Kusch, Millman, and Rabi, Physical Review 55, p. 666, 1939). Of the three models, i.e., the alpha-particle model, a two-body model, and the Hartree model, the last probably gives the best interpretation of experimental data. From the spectral data on Li^7 and He^5 and theories concerning their low excited states (Inglis, Physical Review

NUCLEAR PROPERTIES (continued)

50, p. 783, 1936; and 56, p. 1178, 1939; Breitt and Stehn, Physical Review 53, p. 459, 1938; Kittel, Physical Review 62, p. 109, 1942; Dancoff, Physical Review 58, p. 326, 1940), it is concluded that the $^2P_{1/2}$ state in Be^9 is a bound state. If this is the case; the magnetic dipole transition from $^2P_{3/2}$ to $^2P_{1/2}$ should be observed in inelastic scattering experiments or by detection of the gamma ray resulting from the transition.

PARTICLE ACCELERATORS

1446 Experimental Work on Corrugated Waveguides and Associated Components for Linear Electron Accelerators, by L. B. Mullett and B. G. Loach. Proceedings of the Physical Society 61, p. 271-284, September 1, 1948.

This paper describes experimental work carried out on corrugated waveguides in connection with the development of an electron linear accelerator. The general problem of feeding R.F. power from a conventional rectangular waveguide is considered and several successful "feeds" are described. Finally, the work carried out on corrugated circular waveguides with continuously varying phase velocities and their associated "feeds" for the 0.5 Mev and 4 Mev sections of long accelerators is described in some detail. It is shown that the experimental results are in close agreement with the theoretical treatment. 10 curves, 5 diagrams, and 2 tables.

1447 Theoretical Design of Linear Accelerator for Electrons, by W. Walkinshaw. Proceedings of the Physical Society 61, p. 246-254, September 1, 1948.

Considering a circular corrugated waveguide as an electron accelerator, the dependence of phase velocity on frequency and guide dimensions has been obtained analytically and was found to be in close agreement with experimental values. Tables have been computed for designing accelerator tubes for any frequency and R.F. power. In addition to tabulated data on phase velocity as a function of guide dimensions, curves are given of the variation of electron phase and velocity with distance, of the dependence of axial electric field on phase velocity and inner guide radius, and of electron motion in a uniform traveling wave.

1448 Traveling Wave Linear Accelerators, by R. B. R -Shersby-Harvie. Proceedings of the Physical Society 61, p. 255-270, September 1, 1948.

Acceleration of electrons by means of an electromagnetic wave traveling down a circular corrugated tube is considered. The relevant properties of corrugated tubes are derived and the factors influencing electron energies. Some numerical results are also quoted for a wavelength of 10 cm. The problems of high energy accelerators are discussed briefly and illustrated by calculations which have been made for a 500 Mev accelerator. 6 curves and 26 references.

1449 World's Accelerators. Scientific American 179, No. 4, p. 18-19, October 1948.

A world map of the various accelerators built and planned to date is presented. It also locates the eight atomic piles that have been built for research purposes.

PHYSICS, GENERAL

1450 Electrons in Gases, by Sir John Townsend, F.R.S. London, Hutchinson's Scientific and Technical Publications, 1948. 166 p.

The three principal topics covered are: (1) the behavior of slow electrons in gases when ionization is unimportant; (2) ionization by collision; and (3) the theory of the spark discharge. Fundamental principles of electrical discharges and electronic motion in gases which are necessary to the development of the aforementioned topics are also treated.

1451 The Emission of Negative Ions from Oxide Coated Cathodes, by R. H. Sloane and C. S. Watt. Proceedings of the Physical Society 61, p. 217-234, September 1, 1948.

PHYSICS, GENERAL (continued)

The negative ions emitted from an oxide coated cathode and nearby electrodes have been analyzed, using both a demountable metal mass spectrometer and glass sealed-off tubes to which normal cathode-ray tube high-vacuum technique could be applied. A diagram of the glass sealed-off tube and mounting is shown. The mass-to-charge ratios of a large number of negative ions from the different electrodes have been determined. Negative ion mass spectra are shown, and a table of negative ions which have been identified using oxide coated cathodes is given. The latter includes, in addition to experimental data taken by the authors, data taken by Schaefer and Walcher (Zeitschrift für Physik 121, p. 679, 1943), Bachman and Carnahan (Proceedings of the Institute of Radio Engineers 26, p. 529, 1938), and Broadway and Pearce (Proceedings of the Physical Society 51, p. 335, 1939). Retarding potential measurements have enabled energy distribution curves to be plotted for the more intense ion beams, and permit of discrimination between negative ions produced thermionically and those produced by bombardment. Such curves are shown for oxygen, hydrogen, and ions having 26 and 42 for the M/e ratio. Some observations have been made on the dependence of the ionic thermal emission on the cathode temperature, and the variation of this emission with time after changes in cathode temperature, accelerating field, and cathode surface conditions. The results are discussed and compared with those of other workers in this field. 2 tables, 1 diagram, 12 curves, and 24 references.

1452 Generalized Virial Theorems, by Harvey Einbinder. Physical Review 74, p. 803-805, October 1, 1948.

The virial theorem of Milne (Philosophical Magazine 50, p. 409, 1925) is extended to include frictional forces which are functions of position and time, while that of Fock and Krutov (Physikalische Zeitschrift der Sowjetunion 1, p. 756, 1932) is given a much simpler derivation and is extended to include non-conservative systems. The relation between PV and the moments of E, v, and E_r (V. Danilov, Zeitschrift für Physik 63, p. 692, 1930) is derived for a general ideal relativistic gas. Finally, a proof of the mathematical equivalence between the kinetic and statistical methods of deriving the virial theorem is given.

1453 Interatomic Distances and Nuclear Quadrupole Couplings in ClCN, BrCN, and ICN, by A. G. Smith, Harold Ring, W. V. Smith, and Walter Gordy. Physical Review 74, p. 370-372, August 15, 1948.

Accurate determination of the structures of the molecules, as well as the quadrupole couplings, were made by microwave absorption on samples containing C^{13} and C^{14} isotopes. Tables are given containing the calculated and observed hyperfine structures of BrCN and ICN caused by the halogen nuclei. The nitrogen effects were not investigated since the nitrogen nuclear coupling in these molecules has been carefully determined in recent works (W. Gordy, et als, Physical Review 72, p. 259 1947; A. G. Smith et als, Physical Review 73, p. 633, 1948. A table is also given containing the calculated hyperfine structure of ClCN, as are tables giving the halogen nuclear quadrupole couplings, the moments of inertia calculated from spectral data, and the internuclear distances obtained. It is seen that the C-X internuclear distances are shorter than those for corresponding methyl halides, due to resonance between the structures, $X^+ = C = N^-$ and $X - C \equiv N$. A lengthening of the CN bond is revealed for the first time. The moments of inertia for the molecules are given.

The following interatomic distances (in A units) are found for the ground vibrational state:

for ClCN	for BrCN	for ICN
$d_{C-Cl} = 1.630$	$d_{CBr} = 1.789$	$d_{CI} = 1.995$
$d_{CN} = 1.163$	$d_{CN} = 1.160$	$d_{CN} = 1.159$

The quadrupole couplings in megacycles per second are, from the hyperfine structure: Cl^{35}, -83.5; Cl^{37}, -65.0; Br^{79}, 686; Br^{81}, 573; I^{127}, -2420.

PHYSICS, GENERAL (continued)

1454 Molecular Orbital Method and Molecular Ionization Potentials, by Robert S. Mulliken. Physical Review 74, p. 736-738, October 1, 1948.

Empirical evidence indicates that, other things being equal, the atomic integral α of the LCAO (linear combination of atomic orbitals) molecular orbital method decreases in magnitude, (a) with increasing interatomic distance, (b) with increase in the number of atoms covered by a MO (molecular orbital). Theoretical computations give a satisfactory account of effect (a), and (except for the absolute values of α in many-center cases) also of effect (b). Further study of theoretical approximation methods of the MO type may make possible an increasingly quantitative theoretical understanding of molecular ionization potentials and of other molecular properties. Tabulated values of α and I (ionization potential) from empirical data are given for: graphite, CH_3, C_2H_2, C_2H_4, C_4H_6, C_6H_6, $C_2H_3CH_3$, $C_4H_5CH_3$. Observed and computed alpha values are tabulated and compared for: H_2(r = 0.74A), H_2(for r = 1.07A), C_2H_2(r = 1.20A), and C_2H_4(r = 1.35A).

1455 On the Calculation of Partition Functions for Atoms and Ions in a Partly Ionized Gas, by A. Unsöld. Zeitschrift für Astrophysik 24, Nos. 3-4, p. 355-362, 1948. (In German)

The author reconsiders Planck's theory of thermal excitation and ionization and expresses it in a form suitable for calculation. The relation of this theory to that of Urey and Fermi is considered.

1456 The Relation between Covalent and Packing Radii of Atoms, by A. L. G. Rees. Journal of Chemical Physics 16, p. 995-996, October 1948.

A rule for evaluating the packing radius r of covalently bound atoms, in terms of the single-bond covalent radius r', is formulated as $r^2 = r'^2 + k^2$ where k is the radius of the circular contact area in the XY plane on an electron density contour map shown of a section through the nuclei. Using x-ray crystallographic and collision data for single-bond covalent radii and packing radii, k was calculated for the H, O, Br, I, Se, C, and Te atoms. The mean value of k for these elements was found to be 1.22. Packing radii calculated using the mean k are compared with values obtained using the rule of Pauling (Nature of the Chemical Bond. Ithaca, New York, Cornell University Press, 1945. p. 192). The author's rule gives closer agreement with the experimental data. By assuming that the packing radii r_s and r_d are identical, the following relationship is obtained: $r_s'^2 - r_d'^2 = k_d^2 - k_s^2$, where subscripts s and d indicate a single or a double bond. The relationship is verified with tabulated data on B, C, N, O, Si, S, P, and Cl. The carbon packing radius calculated from the author's rule is found to give more reasonable models of the carbon tetrahalide molecules than the Pauling values.

1457 Secondary Electron Emission by Fast Neutral Molecules and Neutralization of Positive Ions, by H. W. Berry. Physical Review 74, p. 848-849, October 1, 1948. (Letter to the editor)

An investigation is reported of the number of secondary electrons removed from a tantalum surface by argon, helium, and nitrogen ions and molecules with energies ranging from 500 to 4000 electron volts. The purpose of the experiment was to detect the neutral beam formed when a beam of fast-moving ions passes through a gas at rest where the original ion beam is weakened by a charge exchange. A beam of positive ions of the desired energy was passed through a chamber containing the same gas in the form of neutral atoms at a pressure of 10^{-4} to 10^{-3} mm of Hg. The slow ions formed by the charge exchange may be collected on an electrode, while the neutralized fast atoms continue through a hole in the end of the neutralizing chamber, and strike the tantalum surface from which the secondary emission occurs. An expression is derived for the number of secondary electrons removed per neutral atom striking the tantalum surface. With increasing pressure in the chamber, the slow positive ion current will increase, and with more ions being neutralized there will be proportionately more atoms than ions in the beam. Curves of the number of secondary electrons emitted per particle as a function of the energy of the particle are given for helium, nitrogen, and argon ions and neutral

PHYSICS, GENERAL (continued)

atoms of these elements. Curves of the cross section for neutralization of ions in their own gas as a function of the ion energy are also given. The latter were obtained using the slow positive ion current as a measure of the number of neutralizing collisions occurring.

1458 The Specific Charge of the Positron, by J. Barnothy. Physical Review 74, p. 844, October 1, 1948. (Letter to the editor)

From theoretical considerations the specific charge of the positron should be expected to exceed that of the electron. Spees and Zahn (Physical Review 58, p. 861, 1940) have compared the specific charges of the two particles and have found some indication of the expected difference although further experimentation is necessary to establish this.

1459 Theory of Scattering Processes, by Eugene Feenberg. Physical Review 74, p. 664-669, September 15, 1948.

The formal infinite series for the probability amplitudes are transformed by (i) a regrouping procedure which separates out "repetitive" terms from all orders beyond the second and combines them to produce a common factor multiplying all orders, (ii) a procedure of summation to a closed form (essentially an analytical continuation) replacing the above common factor by a generalized energy denominator, and (iii) unlimited repetition of (i) and (ii). Procedure (ii) is based on the generalized energy quantity

$$\epsilon_{gh\ldots np} = E_p + \sum_{q \neq gh\ldots np} \frac{V_{pq}V_{qp}}{(q)} + \sum_{qr \neq gh\ldots np} \frac{V_{pq}V_{qr}V_{rp}}{(q)(r)} + \ldots$$

and the formal identity

$$(E - \epsilon_{gh\ldots np})^{-1} = \frac{1}{(p)}\left[1 + \sum_{q \neq gh\ldots n} \frac{V_{pq}V_{qp}}{(p)(q)} + \sum_{qr \neq gh\ldots n} \frac{V_{pq}V_{qr}V_{rp}}{(p)(q)(r)} + \ldots\right.$$

employing the notation $(x) = E - E_x$.

1460 Notes on Feenberg's Series—Rearrangements, by Paul I. Richards. Physical Review 74, p. 835-836, October 1, 1948. (Letter to the editor)

A simplification of the infinite-series rearrangement procedure recently employed by Feenberg (Physical Review 74, p. 664, 1948) is effected by introducing a specialized notation so that the expressions involved can be handled in closed form.

QUANTUM MECHANICS

1461 Contribution to the Theory of the Cherenkov Effect, by Guido Beck. Physical Review 74, p. 795-802, October 1, 1948.

The Cherenkov effect is derived from given initial conditions without an a priori admission of the existence of the radiation as in a previous theory (I. Frank and Ig. Tamm, Comptes Rendus (Doklady) de l'Academie des Sciences de l'URSS 14, p. 109, 1937; Ig. Tamm, Journal of Physics, USSR 1, p. 439, 1939). According to Frank and Tamm, the radiation is a natural consequence of relativistic electrodynamics, analogous to supersonic phenomena in the field of acoustics. A rigorous solution is given for the field of a point charge which, moving with uniform velocity, comes from a vacuum to enter the plane surface of an ideal classical dielectric at t = 0. The ideal dielectric medium, which has a dielectric constant ϵ, is assumed to be macroscopic and homogenous and dispersion is neglected. This limits the validity of the obtained expressions to longer wave lengths or to spectral regions in which the dielectric is sensibly constant. As the velocity of the particle approaches $c\epsilon^{-1/2}$, the solution represents a characteristic transition radiation. For velocities exceeding $c\epsilon^{-1/2}$, a characteristic cone is formed, as indicated by the solution.

QUANTUM MECHANICS (continued)

1462 The Energy Levels and Thermodynamic Functions of the Fourth Power Oscillator, by John E. Kilpatrick and Myra Ferguson Kilpatrick. Journal of Chemical Physics 16, p. 781-787, August 1948.

A comparison is made between the Wentzel-Kramers-Brillouin approximations and the numbers obtained by a method of numerical integration for the first three characteristic numbers of the reduced wave equation $\psi'' + (\lambda - \xi^4)\psi = 0$. The fourth, fifth, and sixth numbers have also been calculated by a method of numerical integration, and it is found that the third W. K. B. approximation is correct within .0001. A table of calculated values of $-(F - H_0)/RT$, $(H - H_0)/RT$, S/R, and C/R over the range $h\nu o/kt = 0$ to 10 is given.

1463 A First-Order Variational Principle for Classical Electrodynamics, by F. J. Belinfante. Physical Review 74, p. 779-781, October 1, 1948.

The author achieves a unification of the methods of classical mechanics and quantum mechanics by a modification in the mathematical procedure. The slightly different setup of the canonical equations in the two systems of mechanics, which the author reconciles, arises from the fact that, whereas the quantum mechanics equations for the wave function of an electron are first-order differential equations (with respect to time), differential equations of the second order are common in classical theories. The influence of classical methods often results in the use of second-order equations in developing the quantum theory of particles of integer spin, thus causing a difference between the treatment of Fermi-Dirac and of Einstein-Bose particles. However, if only first-order equations are used, the superfluous distinction between integral and half-odd-integral spin fields is avoided. The classical theory of a point charge in an electromagnetic field of force is set up from this point of view.

1464 A New Method for the Treatment and Presentation of Wavemechanical Problems. Part I. (Neue Behandlungs-und Darstellungsmethode Wellenmechanischer Probleme), by Hartmut Kallmann and Max Pasler. Annalen der Physik 2, 6th ser., p. 292-304, 1948. (In German)

This article and the one to follow aim to show that, by using the Laplacian transformation, it is possible to represent and treat the wavemechanical problems in a new, in part considerably simpler, way than has been done up to now. In particular, this first article, after a brief elucidation about the Laplacian transformation, treats the radiative part of the H atom. There, the discrete as well as continuous Eigen function values may be obtained from the single equation:

$$\phi(p) = \frac{C(p - 1/2)^{\beta+\alpha}}{(p + 1/2)^{\beta-\alpha}}$$

1465 A New Method for the Treatment and Presentation of Wavemechanical Problems. Part II. A General Treatment, by Means of the Laplacian Transformation, of the H Atom with Optional Initial Conditions and Their Physical Significance (Allegemeine Behandlung des H-Atoms mit Beliebigen Anfangsbedingungen Mittels der Laplace-Transformation and Deren Physikalische Bedeutung. Mitteilung II zu, "Eine neue Behandlungs-und Darstellungsmethode wellenmechanischer Probleme") by Hartmut Kallman and Max Pasler. Annalen der Physik 2, 6th ser., p. 305-320, 1948. (In German)

The physical significance of the Laplacian transformation, used in Part I, is explained, and the previously obtained transformed differential equations are derived in a different manner. For further elucidation of the method used, the differential equation of the Hermetic polynomials is treated. The differential equation of the radiative part of the H atom was then examined and no suppositions were made as to initial conditions; according to this method, the values of the function may also be examined for non-Eigen values, and the null value of the function may be obtained directly from the simplified transformed equations.

QUANTUM MECHANICS (continued)

1466 On the Classical Equations of Motion of Point Charges, by Peter Havas. Physical Review 74, p. 456-463, August 15, 1948.

A theoretical discussion of the five different sets of equations of motions, 3 from field theory, and 2 from action at a distance, is given, as is a summary of assumptions and results in tabular form. The equations differ mathematically only in fields which represent empty-space solutions. Acceptance of the Wheeler and Feynman condition of "complete absorption" leads to the radiation damping term in the equations of motion of the many-bodied problem.

1467 On the Motion of Point Electrons, by U. Haber-Schaim. Physical Review 74, p. 836-837, October 1, 1948. (Letter to the editor)

The equations obtained by Eliezer (Reviews of Modern Physics 19, p. 147, 1947) generalizing Dirac's (Proceedings of the Royal Society A167, 1938) method of introducing advanced fields to the study of the motion of a point electron are obtained in a different manner. Pryce (Proceedings of the Royal Society A168, p. 389, 1938) has derived finite equations of motion for a point electron, as well as finite electromagnetic self-energy by subtracting a symmetric non-divergent tensor from Maxwell's energy-momentum tensor. To assure the non-divergence of the former, a particular relationship was assumed. The author finds that there exists a non-divergent tensor with singularities of the second order on the world line which does not satisfy the relationship assumed by Pryce. By modifying the expression for such a tensor expressed in Pryce's notation, the equations of Eliezer are obtained. The physical meaning of the generalization, from Pryce's point of view, is discussed.

1468 Quantum Theory of the Point Electron. Part I, by Mario Schonberg. Physical Review 74, p. 738-747, October 1, 1948.

A new treatment of the quantum theory of the electromagnetic field is discussed. The interactions between the particles and their interactions with the radiation field are treated according to the ideas of the author's classical theory, The radiation field is taken as a difference of two fields analogous to the field of the Heisenberg-Pauli electrodynamics; however, the commutation rules for the radiation field differ essentially from those of the Heisenberg-Pauli electrodynamics. In the formalism adopted by the author it is possible to avoid all the divergences by a suitable choice of the wave function of the system particles plus field. The physically relevant wave functions satisfy wave equations similar to those of systems with finite numbers of degrees of freedom, although they are also exact solutions of the Schrodinger equation of the system particles plus field which has an infinite number of degrees of freedom. There is also the possibility of getting finite non-vanishing self-energies.

1469 Polarization and Direction of Propagation of Successive Quanta, by Donald R. Hamilton. Physical Review 74, p. 782-788, October 1, 1948.

A theoretical investigation was made of the correlation between the direction of propagation of one quantum and the polarization of another quantum, for two quanta emitted successively (in any order) by a radiating system. This correlation may be used to determine the relative parities of all three levels of the radiating system by means of a simple relationship. Results are summarized for identification of the possible combinations of dipole and quadrupole radiation. The discussion is also applicable to certain types of resonance radiation.

1470 Quantum Statistics and the ℵ Theorem, by Harvey Einbinder. Physical Review 74, p. 805-808, October 1, 1948.

The thermodynamic consequences of the state equation $PV = sE$ are investigated. For such a system $E = V^{-S}\phi(TV^S)$, $S = \chi(TV^S)$, and $A = V^{-S}\psi(TV^S)$. During an adiabatic change TV^S, EV^S, and $PV^{1+1/S}$ are constant. The ℵ theorem is derived: A system of mechanically non-interacting particles

QUANTUM MECHANICS (continued)

in equilibrium in a field-free space, which individually obey the laws of non- or completely relativistic quantum mechanics, has PV = sE; as T→0, then S→C′; and it either has a zero-point energy, E = CV^{-S}, $(\partial E/\partial V)_T > 0$, or it condenses, $P = CT^{1+1/s}$, $(\partial E/\partial V)_T < 0$. The theorem is used to predict that a strongly degenerate gas obeying intermediate statistics will possess a zero-point energy, $E = CV^{-2/3}$. Further, it clarifies the statement that the third law is a quantum mechanical law, showing that it is satisfied by such a general system. If PV = sE, a necessary condition for it to be obeyed is $(\partial E/\partial V)_T = 0$; a statistical attraction or repulsion must be present, i.e., $(\partial E/\partial V)_T$ greater or less than zero, respectively. Finally the H theorem yields an almost intuitive demonstration of the Einstein condensation phenomenon is Bose-Einstein statistics.

1471 The Theory of Magnetic Poles, by P. A. M. Dirac. Physical Review 74, p. 817-830, October 1, 1948.

A primitive theory of the author's (Proceedings of the Royal Society A 133, p. 60, 1931) describing the motion of a pole in the field of a charged particle whose motion is given, or the motion of a charged particle in the field of a pole whose motion is given, is extended. All the equations of motion for magnetic poles and charged particles interacting with each other through the medium of the electromagnetic field are obtained in accordance with the rules of quantum mechanics. The importance of a theory of magnetic poles is related to the known quantization of electric charges. If the assumption is made that a particle with a single magnetic pole can exist and that it interacts with charged particles, the laws of quantum mechanics require the quantization of electric charge, all charges being integral multiples of a unit charge e such that eg = 1/2hc, where g is the pole strength. Thus, the existence of magnetic poles is essential to the one theory proposed to account for electric charge quantization. The large value of the quantum of pole may account for the fact that it has not been observed, since two one-quantum poles of opposite sign attract each other with a force $(137/2)^2$ times as great as that between two one-quantum charges at the same distance. The estimated binding energy is possibly of the order of 5×10^8 ev. Atomic processes where energies of this order are available are suggested as possible sources of particles with poles. They would appear as heavily ionizing particles distinguished by the production of a roughly constant amount of ionization throughout their range.

1472 The Use of Phase Space in Classical and Quantum Theory, by H. C. Corben. Physical Review 74, p. 788-794, October 1, 1948.

The symmetry between position and momentum space in classical and quantum mechanics may be extended by closer consideration of the concept of phase space. The kinematics of a single particle in phase space, to which is associated a metric which describes both the gravitational and the electromagnetic fields acting on the particle, is discussed. The formulation is applicable only to a charged particle, and implies that for such a particle in an electromagnetic field the Poisson bracket of two position coordinates does not vanish in general, so that in quantum theory these coordinates do not commute. A fundamental constant is introduced as the ratio of the natural and Gaussian units of electromagnetic field strengths and, expressing this constant in terms of h and a length l, the theory satisfies a correspondence principle with present theory in the limit l→0. By postulating that $l \sim 10^{-13}$ cm, one is led to the basis of a theory which is indistinguishable from present theory for field strengths small compared with $(137)^{1/2} e l^{-2}$, but which leads to essential modifications for the interaction of charged particles separated by distances of the order of nuclear dimensions.

RADIATION SICKNESS

1473 Rutin Treatment of Capillary Fragility. Nutrition Reviews 6, p. 301-303, October 1948.

Nine references are cited in this review and the conclusion is made that under certain circumstances, at least, rutin has a definite antihemorrhagic tendency. In particular, Rekers and Field (Science 107, p. 16, 1948) found that the hemorrhagic lesions induced in dogs by a single (mid-lethal)

RADIATION SICKNESS (continued)

dose of x-irradiation were to a large measure prevented and survival greatly prolonged by administration of rutin.

RADIOACTIVITY

1474 The Beta-Spectrum of $Hg^{203,205}$, by D. Saxon. Physical Review 74, p. 849-850, October 1, 1948. (Letter to the editor)

The 180° beta spectrometer has been used to measure the long-lived $Hg^{203,205}$ activity. The sample, in oxide form, was irradiated in the Argonne heavy-water pile. After allowing a month for decay of the shorter activities, half-life measurements were started. The curve of counting rate as a function of time is shown, which indicates a single activity of 43.5 ± 0.5 days, which is considerably shorter than the value obtained by Friedlander and Wu (Physical Review 63, p. 227, 1943). Data are still being taken to eliminate the possibility of a longer-lived activity which might explain the discrepancy. The spectrum shape is shown for window thicknesses of 0.05 mg/cm^2 and for about 0.2 mg/cm^2. The true beta-end-point is hidden in the K and L conversion lines of the gamma ray; hence the previous beta-end-point measurements which included these lines are too high. The true end-point is found to be 205 ± 10 Kev and is obtained using the Kurie plot of the Fermi theory, the curve of which is shown. The $f \cdot t$ value was computed using this end-point to be 2.6×10^6, which places the activity in the first forbidden empirical classification. However, from the linearity of the Kurie plot, the spectrum shape, when visible, is allowed. Thus the total forbidden correction factor is constant with energy, the theory giving this for $\Delta J = 0, \pm 1$, with any of the interactions for heavy elements (Konopinski and Uhlenbeck, Physical Review 60, p. 308, 1941). The conversion coefficients are:

E (γ)	K	L	M	K/L	L/M
286 (Kev)	18%	6%	≤0.5%	3	≥12

1475 The Beta-Spectrum of S^{35}, by R. D. Albert and C. S. Wu. Physical Review 74, p. 847-848, October 1, 1948.

This letter to the editor is based upon AECD-2227 which has been abstracted previously. See Abstract No. 1181.

1476 Beta Spectrum of Tritium, by S. C. Curran, J. Angus, and A. L. Cockroft. Nature 162, p. 302-303, August 21, 1948. (Letter to the editors)

A new technique for rapid and accurate detection and energy measurement of β rays, conversion electrons, γ rays and X rays from weak sources has been developed. It is applicable to radiations of energy 0.5 - 150 Kev, and uses a proportional counter connected to a high-gain linear amplifier. The beta spectrum for tritium over the range 1-18 Kev is given. A maximum, which is wider than the theoretical curve maximum, is observed at 2.5 Kev. The upper limit is 16.9 ± 0.3 Kev. The application of the neutrino theory to the upper end of the spectrum seems justified, and a neutrino mass of less than m/300 is indicated.

1477 The Disintegration of the Gold Isotopes, Au^{194}, Au^{195}, and Au^{196} by Electron Capture (Der Zerfall der Goldisotope Au^{194}, Au^{195}, und Au^{196} durch Elektroneneinfang), by R. Steffen, O. Huber, F. Humbel, and W. Zünti. Helvetica Physica Acta 21, p. 194-197, 1948. (In German)

The radioactive isotopes of gold resulting from the bombardment of platinum with 7-Mev protons are investigated by means of spectrometer and coincidence measurements. Disintegration schemes, half-lives, energy of conversion electrons, and gamma ray transitional energies are listed in tabular form for Au^{194}($T_{\frac{1}{2}}$ = 39 hrs), Au^{195}($T_{\frac{1}{2}}$ = 180 days), Au^{196}($T_{\frac{1}{2}}$ = 133 hrs). Relative intensities of the conversion lines are also given. It was proven that the 3 isotopes disintegrate by K-capture.

RADIOACTIVITY (continued)

1478 Excitation Levels of the Au^{197} Nucleus (Anregungs-Niveaux des Au^{197}-Kernes), by O. Ruber, R. Steffen, and F. Humbel. Helvetica Physica Acta 21, p. 192-194, 1948. (In German)

The energy levels of the Au^{197} nucleus were measured in a magnetic semicircle-spectrometer by detecting the conversion electrons of the gamma transitions. L(63 Kev), M(73.5 Kev), and N(76.5 Kev) conversion electrons of gamma radiation 0.077 Mev were detected. The absolute conversion coefficient of 0.077 Mev gamma transition was: $\alpha = \alpha_L + \alpha_M + \alpha_N = N_e/(N_e + N_q) = 0.76 \pm 0.1$. The value for $\alpha_L = 0.58 \pm 0.08$ and for $\alpha_M + \alpha_N = 0.18 \pm 0.04$.

The disintegration energy of the 7.5 second Au^{197} was found to be $E_\gamma = 0.273$ Mev. By means of beta-beta coincidence measurements it was found that the isotope emits actually 2 converted gamma lines in cascade. No conversion electrons of a γ_2-radiation of 0.077 Mev are noted. The results obtained may be explained by assuming that the energy $E_{\gamma 2}$ is of the same order of magnitude as E_γ.

1479 Disintegration of Tc^{95} and Tc^{96}, by H. Medicus, A. Mukerji, P. Preiswerk, and G. de Saussure. Physical Review 74, p. 839-840, October 1, 1948. (Letter to the editor)

The Tc isotope of mass number 96, which disintegrates by K-capture and has a 104-hour half-life, (Edwards and Pool, Physical Review 69, p. 253, 1946; 72, p. 384, 1947; Gugelot et als, Helvetica Physical Acta 19, p. 418, 1946) has been investigated in more detail. The conversion electrons were investigated by means of a magnetic lens spectrometer. Strong lines corresponding to gamma energies of 771, 806, and 842 Kev (within 2 Kev) were found along with weak conversion lines for gamma rays of 1119 and 312 Kev. Coincidence measurements indicated that the former are emitted in three-fold cascade and that the 1119 line is probably also emitted in cascade with the 771 and 842 lines. The ratio of K-capture x-ray quanta to gamma quanta was determined by absorption in aluminum. A decay scheme for 104-hour Tc^{96} is shown diagrammatically; conversion electron curves for 104-hour Tc^{96} and 20-hour Tc^{95} are also shown. For the latter, conversion lines corresponding to gamma energies of 762, 932, and 1071 Kev were found. Relevant data collected by Eggen and Pool (Physical Review 74, p. 57, 1948) are discussed. A more detailed report is to appear in Helvetica Physica Acta.

1480 Excitation of Metastable Nuclear States with 1500 Kv X-Rays, by B. Trumpy and J. J. Orlin. Bergens Museums Arbok 1945, No. 7. 23 p.

The authors present a report on some experiments with Geiger-Müller counters. They show that the radiation equilibrium between the exciting x-rays and the secondary radiation from an assumed metastable state will nearly be reached after an irradiation period of about 3 times the half-life period of the substance irradiated. On this basis the activity curves found by using different irradiation periods are easily interpreted. A half-life period of 40 seconds was shown with great accuracy after the excitation of a silver counter tube with 1500 kv x-rays. Various filling gases, various tightening materials and metal threads in the tube were used; the counter wall was prepared in different ways, and was given a coating of "trolitul" of different thickness, but the results obtained were always the same. Some investigations are concerned with the question of whether there is a minimum excitation energy for the observed half-life periods in the high voltage region.

1481 On the Half-Life of K^{40}, by T. Graf. Physical Review 74, p. 831, October 1, 1948. (Letter to the editor)

Scattering experiments have been carried out which indicate that the value for the beta-decay half-life of K^{40} which has been determined as $(7 \pm 1) \times 10^8$ years by Bleuler and Gabriel (Helvetica Physica Acta 20, p. 67, 1947) is too small. In the earlier determination of the absolute half-life, numerous disintegration electrons which were not directed toward the counter originally were

RADIOACTIVITY (continued)

probably counted as a result of back-scattering. Scattering experiments in which the back-scattering was eliminated, by mounting the foil on the counter with the activated side outwards, have been performed. The beta radiations of four different K^{40} sources were compared with those of three UX_2 sources. Using different counters and the various sources, results were obtained which agreed within the limits of experimental error, i.e., 2 to 4 per cent. The beta-decay period thus obtained is $(13.7 \pm 1.5) \times 10^8$ years. This is close to a previous value (A. Bramley and A. K. Brewer, Physical Review 53, p. 502, 1938) of $(14.2 \pm 3) \times 10^8$ years determined prior to the measurements of Bleuler and Gabriel. Furthermore, the gamma:beta ratio, previously reported as 0.07 (E. Gleditsch and T. Gráf, Physical Review 72, p. 640, 1947), must be increased to 0.127 ± 0.012. A slight revision in the branching ratio, along with the new value for the beta-decay period, results in a total half-life of $(5 \pm 1.5) \times 10^8$ years for K^{40}.

1482 Radioactive Kr Isotopes, by L. L. Woodward, D. A. McCown, and M. L. Pool. Physical Review 74, p. 761-764, October 1, 1948.

The production, identification, and characteristic radiations of a new isotope, Kr^{77}, are described; in addition, the location and characteristic radiations of the Kr^{79} isotope and the production of Kr^{85} by alpha bombardment are discussed. The radioactive isotope, Kr^{77}, of 1.1 hour half-life was obtained from the reaction Se^{74} $(\alpha,n)Kr^{77}$ in krypton; the Se^{74} was enriched electromagnetically from 0.9% to 14.1%. Tabulated abundance percentage data for the various stable selenium isotopes in the natural and enriched samples are given, along with beta-decay curves used to identify the new krypton isotope.

Aluminum absorption measurements indicate a positron end point of 1.7 Mev for Kr^{77}; these data are shown graphically. In addition to the annihilation radiation, both gamma and x-ray activities were observed, the latter being attributed to K-capture. The ratio of K-capture to positron emission from the $Se^{74}(\alpha,n)$ reaction was computed as 2.6. The isotope Kr^{79} of 1.42 day half-life was produced by an (α,n) reaction on electromagnetically enriched Se^{76} and a positron end point of 1.0 Mev determined by aluminum absorption measurements. Again gamma radiation and K-capture were observed. The K-capture to positron emission ratio was computed to be 50. The cross-section ratio for formation of Kr^{77} compared to Kr^{79} by alpha-particle bombardment of selenium is computed as 1.4.

1483 Relative Effective Cross Sections for the (γ,n) Process with Lithium Gamma-Radiation (Quantum Energy = 17.5 Mev) (Relative Wirkungsquerschnitte für den (γ,n)-Prozess mit der Lithium-Gamma-Strahlung (Quanten energie = 17.5 Mev), by H. Waffler and O. Hirzel. Helvetica Physica Acta 21, p. 200-203, 1948. (In German)

A table of relative effective cross-sections of various isotopes for the (γ,n) reaction is given. A remarkable rise occurs after Ca^{40}. The absolute value of the maximum cross section for Cu^{63} was determined and found to be $\sigma_{max}(\gamma,n) = 6 \times 10^{-25}$ cm^2 for gamma quanta of 22 Mev. This cross section was used as a reference and assigned a relative value of 100.

1484 Short-Lived Isomers of Nuclei, by S. DeBenedetti and F. K. McGowan. Physical Review 74, p. 728-735, October 1, 1948. (See also MDDC-281)

A systematic search for short-lived nuclear isomers having half-lives in the range 10^{-6} to 10^{-3} sec. was conducted using the method of delayed coincidences between two Geiger counters. Detection of these short-lived metastable states was accomplished by measurement of the time interval between beta decay and gamma (or internal conversion electron) emission. Diagrams of the counters and circuit used are given. Data for 56 isotopes giving negative results are tabulated, along with data on experimental conditions. A detection sensitivity graph for the method used in detecting delayed conversion electrons is also given. The only short-lived isomeric states discovered were: Ta^{181*} (22 microsec), Re^{187*} (0.65 microsec), Tm^{169*} (1 microsec), and Tm^{171*} (2.5 microsec). Curves

RADIOACTIVITY (continued)

for absorption of radiation from Hf^{181}, W^{187}, and Yb^{169} are given along with decay curves for Tm^{171*} and Tm^{169*}. The authors pointed out that the method used does not necessarily detect all the isomeric states of the 60 nuclei studied, since for detection by the method used: 1) the metastable state must be reached through beta disintegration, 2) the radiation from the metastable state must be strongly converted, and 3) the half-life must lie within the sensitivity range of the detector, which decreases rapidly for half-lives smaller than 1 microsecond. Using different techniques for production and detection of nuclear excited states might disclose many more short-lived isomers in this range.

1485 Theory of Electrodisintegration of Be^9, by E. Guth, C. J. Mullin, and J. F. Marshall. Physical Review 74, p. 834-835, October 1, 1948. (Letter to the editor)

Using the theoretical photo-disintegration cross section obtained by Guth and Mullin (Physical Review 74, p. 833-834, October 1, 1948), the cross section for the disintegration of Be^9 by electrons has been calculated as a function of energy. The result, shown graphically, agrees well with the experimental curve based on Weidenbeck's data (Physical Review 69, p. 236, 1945). Assuming that the cross section for photo-disintegration results from photo-electric transitions only, the determination of the electrodisintegration cross section is reduced to an electromagnetic, rather than a nuclear, problem. Previous theories are discussed.

1486 Theory of the Photo-Disintegration of Be^9, by Eugene Guth and Charles J. Mullin. Physical Review 74, p. 833-834, October 1, 1948. (Letter to the editor)

The data of Wattenberg and his associates (Physical Review 73, p. 545, 1948) and other workers on the photo-disintegration cross section of Be^9 are interpreted theoretically. Applying a two-body model and assuming that the ground state is a $^2P_{3/2}$ state, the possible transitions are discussed. The observed values for the cross section as a function of energy are shown graphically. Although the empirical data shown only one maximum, there is also a second beyond the range of the data, since the incident photons should produce transitions from the P state to the D state, as well as from the P state to the S state. The interaction between the Be^8 and the neutron, producing Be^9, is represented by a rectangular potential well, the radius of which is of the order of $3\text{-}5 \times 10^{-13}$ cm. For a radius of 5×10^{-13} cm., the well depth for the P state is 12.16 Mev, while for the S and D states it is determined as 3 Mev. Using these calculations, the first S state is bound by about 100 Kev, resulting in a resonance effect in the disintegration cross section similar to that which would be obtained with a virtual state. A theoretical curve of the photo-disintegration cross section for Be^9 is plotted and compared with the observed data. The theory predicts that the angular distribution of the ejected photo-neutrons should be spherically symmetric for energies near the threshold, in accordance with data taken by Goloborodko and Rosenkewitch (Physikalische Zeitschrift der Sowjetunion 11, p. 78, 1937). Recent experimental work of Davis and Hafner (Physical Review 73, p. 1473, 1948) on the inelastic scattering of protons on Be^9 is discussed.

1487 Evidence of a Variation in Half-Life for Be^7 as a Function of the Degree of Ionization of the Atom (Mise en Evidence de la Variation de Periode du Be^7 en Fonction du Degré d'Ionisation de l'Atome), by Robert Bouchez, Pascaline Daudel, Raymond Daudel, and Roland Muxart. Comptes Rendus Hebdomadaires des Seances de l'Académie des Sciences 227, p. 525-527, September 6, 1948. (In French)

Theoretically the total probability of a nucleus capturing an electron is a function of the number of electrons surrounding the nucleus and thus depends on the degree of ionization. Ionization of an atom whose nucleus disintegrates by capture should cause a variation in the half-live. This has been pointed out by E. Segre (Physical Review 71, p. 274, 1947) and R. Daudel (Revue Scientifique, Paris, No. 3266, fasc. 3, p. 162, 1947), who proposed the study of Be^7 for this effect. Assuming all electrons are in the s state, calculations show that the probability of the capture of the L electrons is approximately 2% of the total probability (Journal de Physique et le Radium 11, p. 336, 1947). Pauling (conferences at

RADIOACTIVITY (continued)

Oxford, 1948) estimates that 50% of the L electrons have the s configuration. This enables an estimate of the amount by which atomic Be and doubly ionized Be might be expected to differ in their half-lives. Metallic Be and beryllium fluoride were used as sources, various considerations indicating an expected discrepancy between these of the order of only 8×10^{-3}. The radioactive sources were obtained in a cyclotron by the reaction ($Li^6(d,n)Be^7$), and the method used to obtain the ionized Be^7 in its fluoride as well as metallic Be^7 is described. Data curves are shown and indicate a difference of at least 1% between the half-lives of the metallic Be^7 and that of the doubly ionized form. The authors claim that this is the first time the half-life has been influenced by chemical means. These experiments also provide experimental verification of L-capture.

RADIOCHEMISTRY

1488 Formation of Hydrogen Peroxide in Water Irradiated with X- and Alpha-Rays, by P. Bonet-Maury and M. Lefort. Nature 162, p. 381-382, September 4, 1948.

An investigation was made into the effect of 0.9 A x-rays and polonium or radon α-rays on water. Curves are given showing that for a given dose of x-radiation the amount of hydrogen peroxide produced depends markedly upon the dissolved oxygen concentration. In water free from oxygen no hydrogen peroxide is detected. When submitted to α-radiation water completely freed from oxygen was seen to have the same yield of hydrogen peroxide as oxygen-saturated water. The effect of temperature was also investigated. In the case of x-radiation the production of hydrogen peroxide decreases regularly with the temperature for oxygen-saturated water. A definite discontinuity is noted marking the passage from water to ice. No hydrogen peroxide was noted below -116°. For α-rays the temperature seems to be without effect on the hydrogen peroxide production, except for the discontinuity at the water-to-ice transition point. Figures are given showing the temperature effects. The results agree with those of previous workers, and it is concluded that hydrogen peroxide plays an important part in the mechanism of the biological effect of radiation. It has been experimentally proven that radon β-rays account for less than 5 per cent of the total effect of α- and β-radiation.

RADIOGRAPHY

1489 Autoradiography of the Thyroid Gland, by Geoffrey H. Bourne. Nature 162, p. 495-496, September 25, 1948.

Normal adult male mice were each given intraperitoneal injections of 25 microcuries of I^{131} in the form of sodium iodide. After two hours they were chloroformed and their thyroid lobes removed and fixed in aqueous formalin. Of the methods used in autoradiography of the thyroid gland (1) mounting sections on glass slides and applying these slides with pressure against the emulsion of a photographic plate, (2) melting photographic emulsion and pouring it over a section, (3) mounting the sections directly on the photographic emulsion, and (4) a modification of (2) by removing from its base Ilford half-tone thin films, dry-stripping emulsion and mounting it on top of the slide-bearing sections, the third was used because it is simple to use, the section may be easily stained, precise histological location of the blackening of the emulsion is obtained, and it is well suited for use in serial sections. It was found that no section of the thyroid was more active than any other in concentrating the radioactive iodine, and there was clear demonstration of its localization in the colloid of the follicles. The smaller follicles appeared to have concentrated the I^{131} more rapidly than the larger. It was of interest that the blood vessels showed no sign of blackening the emulsion. This study suggests that the iodine is still being absorbed two hours after injection and that the more flattened the epithelium the slower the rate of storage in the follicles.

RADIOGRAPHY (continued)

1490 Electronic Radiography and Microradiography, by Jean-Jacques Trillat. Journal of Applied Physics 19, p. 844-852, September 1948.

Two techniques of electronic radiography which utilize secondary photoelectrons liberated by hard x-rays (180 Kev) are described. In radiography by means of reflection, photoelectrons are liberated from the surface of a specimen irradiated with x-rays. Since the number of electrons emitted at a point on the surface will depend on the atomic number of the element losing the electrons, an emulsion sensitive to photoelectrons and in contact with the specimen will provide an image of the surface. Special photographic emulsions of the Lippmann type, which will not be affected by x-rays, are required. The thickness of the sensitive layer is approximately 1/300 mm. A diagram is shown illustrating the principle of this method. Radiographs of metallic surfaces, ores, and alloys are reproduced. The optimum practical range of voltages for this effect is 150-200 Kev. In electronic radiography by transmission, the source of secondary photoelectrons is a thin metal foil of a metal of high atomic number, such as lead, which is pressed against a thin specimen. The electrons thus generated have sufficient energy to traverse the specimen and register on the photographic film or paper. This method will disclose the structure of films about 2 microns thick. Radiographs of films and thin tissues obtained by this method are reproduced.

1491 The Quantitative Theory of Autoradiography Illustrated Through Experiments with P^{32} in the Chick Embryo, by Herman Branson and Louis A. Hansborough. Science 108, p. 327-328, September 24, 1948.

In experiments on the effects of vitamins on phosphorus metabolism in the chick embryo, the autoradiographic technique was studied as a means of determining the distribution of P^{32} between the embryo and the blastoderm. The techniques used and the interpretations made, based on simple principles of photographic sensitometry, showed that the method was capable of yielding quantitative results. Beginning with the Hurter and Driffield characteristic curve expressing the relation between the density and the logarithm of the exposure and progressing through a series of equations, it is shown that the embryo has about 3 times as much radioactive phosphorus per unit area as the blastoderm and is therefore concentrating the available phosphorus at a fairly high rate.

RADIOTHERAPY

1492 Advances in Dermatology, by F. F. Hellier. Practitioner 161, p. 291-297, October 1948.

One section of this article (p. 295-296) is devoted to thorium X (Ra^{224}). Thorium X is of limited value in dermatology. At times it can produce improvement in portwine stains and parasporiasis. Ordinary psoriasis responds only temporarily. Feeny (Lancet 2, p. 506, 1947) claimed to have cured 22 out of 24 cases of alopecia areata by applying the thorium X in varnish (1,500 E.S.U. per cc) at monthly intervals to the bald areas. It is felt that these claims should be regarded cautiously for the essential cause of alopecia areata is psychological.

1493 Dosimetric and Protective Considerations for Radioactive Iodine, by James J. Nickson. Journal of Clinical Endocrinology 8, p. 721-731, September 1948.

In this lecture before the Annual Meeting of the American Association for the Study of Goiter, May 6, 1948, the importance of accuracy in the computation of therapeutic doses is discussed, and examples of computation are given. These are complicated by the fact that the carcinogenic or otherwise toxic amounts of I^{131} to the normal organism have not been determined. The potential hazards to personnel working with radioactive material and measures necessary for their protection are also considered. 4 references.

RADIOTHERAPY (continued)

1494 Hematological Complications Following Therapeutic Treatment with Radioactive Phosphorus (Complicaciones Nematológicas de la Terapéutica con Fósforo Radiactivo). Semana Médica 55, No. 2852, p. 538, September 9, 1948. (In Spanish)

This is a summary of the work of Hempelman, Reinhard, Bierbaum, Moore, and Moore of St. Louis in which they treated 49 patients with such diseases as chronic myeloid leukemia, lymphotic leukemia, leukosarcoma, monocytic leukemia, Hodgkins' disease, polycythemia vera, multiple myeloma, and mycosis fungoides with P^{32}. Following treatment, a third of the patients showed severe degrees of leukopenia and thrombocytopenia and 17 showed a decrease in erythrocytes. Although some of these complications could be attributed to the disease itself, in the majority of cases they were attributed to the P^{32} administered. The efficacy of P^{32} in some of the patients with chronic lymphatic leukemia and chronic myeloid leukemia was of limited value, whereas it was satisfactory in other cases to judge from the changes observed in the leukocytes of patients with leukemia and in the erythrocytes of patients with polycythemia vera. A significant increase in the number of platelets following treatment was observed in three patients suffering from thrombocytopenia.

1495 Radiations and Health, by A. S. McFarlane. Nature 162, p. 480-481, September 25, 1948.

This is a short report on some of the material presented in a symposium on the therapeutic applications of radioactive isotopes held by the Radiology Section of the British Medical Association at Cambridge. This material included the various nuclear reactions which lead to the production of radioisotopes, a review of recent tracer applications, and a review covering all isotopes used therapeutically whether by internal or external administration. Health hazards involved in the use of radioisotopes are briefly discussed.

1496 The Simultaneous Disappearance of Treated and Untreated Tumors after Irradiation, by A. J. Delario. American Journal of Roentgenology and Radium Therapy 60, p. 207-212, August 1948.

At least 400 hopeless cases of malignant new growths in which cures resulted after such inadequate procedures as a biopsy, an incomplete operation, some secondary infection, or some unexplained fever are reported in the literature. From the illustrations given in this paper it is suggested that there may be some very simple chemical change that either enables the body to cope with tumors or permits it to succumb to them. Irradiation, by means of ionization, causes physical and chemical changes in the cell, and these local changes manifest themselves distally by means of the blood and lymph stream. Various cell enzymes such as trypsin, pepsin, and invertase are inactivated and sucrose may be inverted. Patients complain of dizziness, weakness, sleepiness, loss of appetite, nausea, and vomiting. This irradiation sickness has been attributed to a toxic substance, histamine-like substances, decrease in blood sugar and vitamin B_1, and decrease in amount of blood cholesterol. In the light of the close chemical likeness of cholesterol to carcinogenic substances, it is important that cholesterol and its salts are made to disappear from solution following irradiation. Cholesterol is increased in the cancer cell. The fall in blood cholesterol following irradiation may deprive the primary lesion and its metastases of their growth stimulating substance. Cholesterol changes may be produced by other causes. The low level of cholesterol in starvation has caused certain experimental tumors to disappear.

RARE EARTHS

1497 Isotopic Assignment of the α-Activity of Samarium, by N. Feather. Nature 162, p. 412, September 11, 1948.

It is shown that the isotope Sm^{152} is almost certainly the isotope responsible for the α-activity of samarium. Recent results have substantiated this theory.

RARE EARTHS

1498 The Isotopic Constitution of Europium, Gadolinium, and Terbium, by David C. Hess, Jr. Physical Review 74, p. 773-778, October 1, 1948.

This paper is based upon MDDC-1687. MDDC-1687 has been listed and abstracted in Abstracts of Declassified Documents.

SCIENTIFIC RESEARCH

1499 Physics in Central and Southern Europe, by Robert L. Platzman. Science 108, p. 291-294, September 17, 1948.

In Czechoslovakia, cosmic ray investigations using the new Ilford Photographic emulsions are being carried out. The plates are exposed in the high Tatra mountains. In Austria, research on nuclear reactions, using the new Ilford plates, is under way. In Italy, cosmic ray research is in progress. A new high-altitude laboratory, the Cervinia laboratory, was inaugurated in January 1948 on Monte Rosa (11,500 feet) in northern Piedmont.

1500 Research – Everybody's Doing It Now, by T. A. Boyd. ASTM Bulletin p. 53-58, May 1948.

Two cases histories – petroleum research and atomic research are discussed in detail.

SPECTROSCOPY

1501 Fine Structure of the Hydrogen α-Line, by H. Kuhn and G. W. Series. Nature 162, p. 373, September 4, 1948.

Using Fabry-Perot etalons with spacing of 5 mm and 7.5 mm and a deuterium discharge tube immersed in liquid hydrogen run at very low densities, the fine structure of the H_α line was investigated. Photometer tracings are shown. An upward displacement of the $2S_{\frac{1}{2}}$ level by 0.043 ± 0.006 cm^{-1} from its position as given by Dirac's theory is obtained. This does not agree with the values obtained by Lamb and Retherford (Physical Review 72, p. 241, 1947) or Bethe (Physical Review 72, p. 339, 1947) or Dyson (Physical Review 73, p. 617, 1948). A fourth component of the hydrogen α-line fine structure which had hitherto not been resolved was obtained. It is due to the transition $2P_{\frac{1}{2}}$- $3S_{\frac{1}{2}}$, and its separation from the component one is 0.13 ± 0.006 cm^{-1}. The position of the term $3S_{\frac{1}{2}}$ obtained from this measurement agrees with the Dirac theory, but on account of incomplete resolution, the authors do not claim certainty for the value.

1502 Frequency Stabilization of Microwave Oscillators by Spectrum Lines. Part II, by José L. García de Quevedo and William V. Smith. Journal of Applied Physics 19, p. 831-836, September 1948.

The design of both narrow band high stabilization and broad band lower stabilization spectrum line discriminators is developed in a generalized form applicable to various spectrum lines and cavity designs. Comparison with experiment is made for two broad band discriminators utilizing the NH_3 3,3-absorption line at 23,870 megacycles as the frequency determining element. These discriminators used with an amplifier of 2000 gain, reduce drifts by factors of 250 and 1000, respectively, compared to an unstabilized tube. The discriminator characteristic of a 2.16 meter cell using the NH_3 3,3-line is reproduced. The maximum discriminator slope and power input are plotted as functions of line width for the same cell. A schematic diagram of the laboratory model of the spectrum line stabilizer is shown. Frequencies and discriminator characteristics available for ammonia are tabulated.

SPECTROSCOPY (continued)

1503 Isotopic Shift in the Helium Line Spectrum, by Alan Andrew and W. W. Carter. Physical Review 74, p. 838-839, October 1, 1948. (Letter to the editor)

Using some of the enriched He^3 mixture from the apparatus of Andrew and Smythe (Physical Review 74, p. 496, 1948), a discharge tube suitable for photographing the isotopic shift in the spectra was prepared. Hughes and Eckart (Physical Review 36, p. 694, 1930) have derived an expression for the effect on the change in energy levels of the different states of the extra-nuclear electrons produced by the mass difference between the isotopes He^3 and He^4. Using this expression, the expected change in wavelength of the line 2^1P-3^1D, λ 6678 A, is 0.466A. The average value obtained experimentally by the photographic method is 0.471 ± 0.009A. Interferometric measurement of the shift gives a value of 0.467 ± 0.004A.

1504 Nuclear Quadrupole Interaction in CsF, by J. W. Trischka. Physical Review 74, p. 718-727, October 1, 1948.

The electric resonance method of molecular beam spectroscopy has been used under high resolution conditions to study the rotational Stark spectrum of CsF for a single rotational state of the molecule, J = 1. A schematic diagram of the electric resonance apparatus is shown. In this method polar molecules in a single rotational state and a particular state of space quantization are selected from a molecular beam by means of inhomogeneous electric fields which give the desired molecules a unique, sigmoid path in the apparatus. Changes in the beam intensity are observed when a change in the space quantization of the molecule is produced by an oscillating electric field transverse to a homogeneous, steady electric field. Curves are shown of the change in beam intensity, both as a function of strong electric fields (for a frequency of 94.506 mc/sec.) and as a function of frequency (for an electric field of 93.45 volts/cm), for molecules in several different vibrational states. The fine structure produced by the nuclear-molecular interaction is shown on the latter, i.e., the curve for constant electric field. For weak electric fields the observed line widths agree well with the estimated uncertainty width of 10 kc/sec. At stronger fields inhomogeneities in the field cause a broadening of the lines. At sufficiently strong fields the spectrum for CsF contains several broad lines, each of which is due to transitions of molecules in a particular vibrational state. As the field strength is decreased the resolution improves and these lines reveal a complex fine structure, the principal features of which can be explained by the interaction of the electric quadrupole moment of the Cs nucleus, spin 7/2, with the molecular electrons and the F nucleus. The F nucleus, spin 1/2, has no quadrupole moment. A complete, quantitative explanation of the spectra requires the existence of a cosine type coupling between the nuclear spins and the molecular spin of the form $cI \cdot J$, and a correction for the spin-spin interaction of the two nuclei. At weak fields a different type of spectrum appears, permitting an independent evaluation of the nuclear-molecular interactions. The data allow a determination of both the magnitude and sign of the interaction constants. The quadrupole interaction, defined by $(e^2qQ/2h)$, is $(+0.310 \pm 0.002)$ mc/sec. The constants, c/h, for $I \cdot J$ interactions for F and Cs are, respectively, $(+16 \pm 2)$ kc/sec. and (0 ± 1) kc/sec. The difference in the quadrupole interaction for the first two vibrational states is less than the experimental error, i.e., less than one per cent. Application of the method to the measurement of various molecular constants is discussed briefly at the end of the paper.

1505 The Quantometer, A Direct Reading Instrument for Spectrochemical Analysis, by M. F. Hasler, R. W. Lindhurst, and J. W. Kemp. Journal of the Optical Society of America 38, p. 789-799, September 1948.

A thorough theoretical discussion and a schematic drawing are given of the quantometer which consists of three basic instruments—a spectrometer, a recording console, and a source unit to excite the spectra of the samples to be analyzed. The electrical circuits and constants are given in detail for the receiver units, power supplies, sensitivity controls, and recorders. Complete explanations are also given for adjusting and testing the instrument and for operating it. A wide variety of alloys

SPECTROSCOPY (continued)

of the same base material may be analyzed by using the recording console with the interchangeable panel method for direct reading. The over-all flexibility of the instrument and particularly the ease with which receivers may be moved to any point in the working range of the spectrum make it ideal for research work.

1506 Spectroscopic Measurements of X Radiations of the Radio Elements (Measures Spectroscopiques des Radiations X de Radioéléments), by P. Marmier, J. P. Blaser, H. Medicus, and P. Preiswerk. Helvetica Physica Acta 21, p. 198-199, 1948. (In French)

The existence of an isomeric state of the isotope of element 43 (Tc) having a 53-minute half-life has been proven. This isotope was produced by a (p,n) reaction on Mo. The Mo spectra lines are due to K capture accompanying positron emission, and the Tc lines are due to an internal conversion of a gamma line of 33.5 ± 0.4 Kev, which was detected by means of a beta spectrograph. The wave lengths of the $K_{\alpha 2}$, $K_{\alpha 1}$, and $K_{\beta 1}$ lines of Tc were determined by Burkhart, Peed, and Saunders (Physical Review 73, p. 347, 1948), who obtained values by direct excitation of Tc obtained from the Clinton pile. The authors calculated these same values from photographs of spectral lines of Tc using Moseley's formula. The following table compares the results of these two studies.

	Calculated Values (Marmier et als)	Measured Values (Burkhart et als)
$TcK_{\alpha 2}$	677.91 XU	677.9 XU
$TcK_{\alpha 1}$	673.57 XU	673.4 XU
$TcK_{\beta 1}$	600.1 XU	600.0 XU

TRACER APPLICATIONS - RADIOACTIVE

1507 The Formation of Monoiodotyrosine from Radioiodine in the Thyroid of Rat and Man, by Kay Fink and R. M. Fink. Science 108, p. 358-359, October 1, 1948.

Using data obtained from chromatograms prepared from hydrolysates of rat thyroids and from a biopsy specimen from a patient with adenoma of the thyroid, and radioautrographs and a Geiger counter, it is indicated that monoiodotyrosine plays a part in the metabolism of iodine by the thyroid. The total radioactivity in the monoiodotyrosine spot made from rat specimens ranged from about one-third to two-thirds of that shown by the adjacent diiodotyrosine spot, while in the human specimen the activity of the monoiodotyrosine spot was one-half the diiodotyrosine spot. These preliminary tests show that by the use of radioactive reagents it may be possible to determine the concentration of a number of the iodine-containing compounds on an ultramicro scale.

1508 On the Origin of Virus Phosphorus, by Frank W. Putman and Lloyd M. Kozloff. Science 108, p. 386-389, October 8, 1948.

Isotope studies described in this paper demonstrate that when phage is propagated in bacteria maintained in a chemically defined medium, the medium itself can be the ultimate source of 70% of the the virus phosphorus. The remaining virus phosphorus is derived directly from the bacterial host, chiefly from some P fraction other than low-Molecular-weight, acid-soluble compounds. P^{32} was used in these studies. 5 references.

1509 The Retention of Aerosol Particles in the Human Respiratory Tract as a Function of Particle Radius, by Irwin B. Wilson and Victor K. Lamer. Journal of Industrial Hygiene and Toxicology 30, p. 265-280, September 1948.

The retention of aerosol particles in the human respiratory tract has been studied as a function of particle radius and breathing rate using monodispersed aerosols (uniform particle size) of glycerol

TRACER APPLICATIONS - RADIOACTIVE (continued)

and water containing a trace of radioactive sodium. Seven subjects inhaled the aerosol. "Alveolar retention" (smaller bronchi, bronchioles, and alveoli) has been distinguished from total retention by the use of radioactive tracer techniques. The aerosol was produced by condensation of glycerol vapor upon NaCl nuclei containing the tracer element. The water content was controlled by equilibrating the glycerol aerosol with glycerol and water solution. The methods employed are of general applicability for introducing tracers and volatile soluble components into the aerosol. Particle size was measured by means of the higher order Tyndall spectra calibrated in terms of sedimentation rate. The calibration curves, valid for any non-absorbing spherical aerosol of refractive index 1.47, confirms the predictions of the Mie theory of light scattering.

Data are presented for breathing rates from 5 1/2 to 20 cycles per minute. Relative alveolar retentions, measured with a Geiger-Mueller counter placed in the axillary region, showed a marked dependence upon particle size. The aleveolar retention exhibits a maximum with two peaks in the range 0.3μ to 1.0μ in radius. Arguments are presented which indicate that the maximum aleveolar retention is of the order of 45 per cent of the inhaled aerosol. The selection of aerosols in this range of particle size is indicated for maximum "alveolar retention" of therapeutic aerosols. 32 references.

1510 Studies in Rats on the Function of the Pineal Body with the Aid of the Radioactive Phosphorus, by Ulf Borell. Nordisk Medicin 36, p. 2137-2141, 1947.

There is a vigorous metabolism of the phosphorylated intermediates of carbohydrate metabolism in the cells of the pineal body. These intermediates contain much energy. In some of the protein fractions a less lively metabolism is noted. During the infantile period the pineal is at its lowest metabolism. The phosphorus turnover remains at a constant high level in the fertile age and increases somewhat during senility. An increased activity is obtained in the pineal body after castration and the increase is most pronounced in females. After pinealectomy the phosphate metabolism decreases in the ovaries and uterus and increases in the testis.

1511 Ten Years of the Application of Artificial Radioactivity (Dix Ans d'Application de la Radioactivité Artificielle), by Pierre Süe. Paris, Société d'Editions Scientifique, 1948. 258 pp.

This work represents an extensive compilation of literature on radioactive tracers. Material is arranged according to subject and in cases where a content note is necessary it has been added. The material is also indexed according to author and according to the radioelements used. A survey of the radioactive nuclides, based on Seaborg's tables (published in 1944) is included.

1512 The Use of Radioactive Iodine in the Diagnosis of Thyroid Disease, by Sergei Feitelberg, Paul E. Kaunitz, Louis R. Wasserman, and Stephen B. Yohalem. American Journal of the Medical Sciences 216, p. 129-135, August 1948.

Using the affinity of thyroid tissue for radioactive iodine and a collimated Geiger-Mueller counter, the authors have developed a method which when correlated with physical examination permits greater accuracy in the diagnosis of functional thyroid cancer. In this study 60 patients were given I^{131} orally 1 to 2 days before the examination. The tube of the counter was first placed against the skin and on the body midline at the level of the thyroid isthmus and the number of counts per second for 60 seconds was noted. The tube was then moved laterally and counts made at one-half inch intervals. By plotting the counts per second against the distance from midline a "horizontal profile" was formed. "Vertical profiles" were formed from readings taken along the midline. Surveys of the limbs and pelvis to detect metastases were made but not plotted. The graphic description formed by the profile and the presence or absence of metastases form the basis of the method. Since it cannot be used for definitive diagnosis of thyroid disease, it is valid only for preliminary studies. The use of the method is shown in 7 representative cases and the limitations are discussed. 2 references and 9 figures.

TRANSURANIC ELEMENTS

1513 The Transuranium Elements, by Ralph A. James. Science Counselor 11, p. 92-93, September 1948.

An account is given of the discovery and naming of elements neptunium, plutonium, curium, and americium and of the change in the periodic table made necessary by their discovery.

URANIUM

1514 The Emission of Alpha-Particles from the Different Faces of a Radioactive Crystal, by J. H. J. Poole and J. W. Bremner. Physical Review 74, p. 836, October 1, 1948. (Letter to the editor)

Preliminary tests conducted on uranium nitrate using the photographic emulsion technique appear to confirm previous investigators Mather and Kurie (Physical Review 73, p. 1474, 1948) and Merton (Philosophical Magazine 38, p. 463, 1919), who found no difference in alpha-ray emission from the various crystal faces for ThSO and uranium nitrate crystals. Results which differ, obtained by Muhlestein (Archives des Sciences Physiques et Naturelles 2, p. 240, 1920), are discussed. The authors believe that the amount of U^{235} contained in natural uranium could not account for the variation observed by Muhlestein if the effect is attributed to lack of nuclear spherical symmetry, which might be accounted for by the presence of U^{235} of 5/2 or 7/2 spin. The possibility that the orientation of the nucleus was controlled by the crystalline forces is another suggested implication if Muhlestein's results are accepted.

X-RAYS

1515 A New Method of Determining X-Ray Intensities, by N. C. Baenziger. AECD-2333, n.d., decl. October 6, 1948. 4 p. For publication in Journal of Chemical Physics.

A new solution to the problem of determining integrated intensities of x-ray reflections recorded on photographic film has been found which involves the radioactive toning of the film with cobalt ferrocyanide containing Co^{60}. The toning process takes place in a bleaching, $4Ag + [Fe(CN)_6] \rightarrow Ag_4Fe(CN)_6$, and a toning step, $Ag_4Fe(CN)_6 + CoX_2 \rightarrow 4AgX + Co_2Fe(CN)_6$. Spots on the x-ray negative were counted using a Victoreen Geiger-Müller counting tube and a standard scaling circuit. A linear relation between optical density and exposure up to an optical density of two was reported. This method of detecting intensities was tested by measuring the intensities of the (001) reflections from anthracene crystals. The measurement of these intensities compared favorably with those obtained by Robertson (Proceedings of the Royal Society 140 A, p. 79, 1933) and Bauerjee (Indian Journal of Physics 4, p. 557, 1930).

1516 A Temperature-Controlled Frevel Focusing X-Ray Powder Camera, by V. Vand. Journal of Applied Physics 19, p. 852-855, September 1948.

A focusing x-ray powder camera of Frevel type is described, suitable for the study of large cells of organic crystals. It uses a convergent x-ray beam collimated by a multiple slit system and records transmitted reflections only.